

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

**SPECIFICATIONS AND CONTRACT DOCUMENTS  
FOR**

**COUNTY OF SAN BERNARDINO  
ISD Acquisition & Improvements**

851 E. Cooley Avenue  
Colton, CA 92324



Prepared by  
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APRIL 2022

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**SECTION 00 01 03**  
**PROJECT DIRECTORY**

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**END OF SECTION**

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## SECTION 01 03 00

### POST BID INTERVIEW

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 DESCRIPTION

This Section requires the apparent low bidder to attend and participate in a POST BID INTERVIEW with the OWNER and ARCHITECT, prior to award of any contract by the OWNER. The POST BID INTERVIEW will be conducted by the ARCHITECT within fifteen (15) calendar days after the date of bid. The Interview will take place at the Architect's Office.

##### 1.03 PURPOSE

- A. Contractor acknowledgment of a complete and accurate bid.
- B. Contractor submission of a fair and equitable bid.
- C. Fair comparisons of bid.

##### 1.04 REQUIRED ATTENDANCE

- A. A duly authorized representative of the apparent low bidder is required to attend the POST BID INTERVIEW, in person.
- B. The apparent low bidder's authorized representative must have signatory authority on behalf of the apparent low bidder.
- C. Failure to attend the POST BID INTERVIEW will be considered just cause for the Owner to reject the Bid.

##### 1.05 POST BID INTERVIEW PROCEDURE

- A. The ARCHITECT will review the Bidder's Proposal with the attendees.
- B. The ARCHITECT will review the Contract Documents with the attendees, including but not limited to:
  - 1. Insurance
  - 2. Bonding
  - 3. Addenda
  - 4. Pre-Bid Clarifications
  - 5. Bid / Voluntary Alternates
  - 6. Schedule of Values for all Sub-Contractor Work listed according to the Table of Contents for the Project Manual.
  - 7. Value Engineering
  - 8. The Contract Plans
  - 9. The Contract Specification
  - 10. Critical Materials
  - 11. General Contract Schedule Requirements

**Contractor's Initial** \_\_\_\_\_



- 12. Prevailing Wage Requirements
- 13. Liquidated Damages
- 14. Required Docs for Contract Administration
- 15. Contract Coordination Requirements

1.06 POST BID INTERVIEW DOCUMENTATION

The ARCHITECT will document the POST BID INTERVIEW on the form attached to this Section. Both the Apparent Low Bidder and the OWNER are required to sign the POST BID INTERVIEW Documentation. The POST BID INTERVIEW Documentation is a Contract Document, and all items recorded in the POST BID INTERVIEW Documentation are part of the Contract and shall be enforced accordingly.

**PART 2 – INFORMATION**

2.01 BIDDER INFORMATION

- A. Name: \_\_\_\_\_
- B. Phone: \_\_\_\_\_
- C. Fax: \_\_\_\_\_
- D. Date: \_\_\_\_\_
- E. Time: \_\_\_\_\_

2.02 INTRODUCTIONS / SIGN-IN

- A. Contractor:
  - 1. \_\_\_\_\_
  - 2. \_\_\_\_\_
  - 3. \_\_\_\_\_
- B. Owner:
  - 1. \_\_\_\_\_
  - 2. \_\_\_\_\_
  - 3. \_\_\_\_\_
- C. Architect:
  - 1. \_\_\_\_\_
  - 2. \_\_\_\_\_
  - 3. \_\_\_\_\_

**Contractor's Initial** \_\_\_\_\_

### PART 3 – INTERVIEW

#### 3.01 PURPOSE OF INTERVIEW IS TO ASSURE

- A. Contractor acknowledgment of a complete and accurate bid.
- B. Contractor submission of a fair and equitable bid.
- C. Fair comparisons of bid.

#### 3.02 CONTRACTUAL REQUIREMENTS

A. Can you meet all specified bonding requirements?	Yes	No
B. Can you meet all specified insurance requirements?	Yes	No
C. Acknowledge that you are required to comply with the prevailing wage Requirements?	Yes	No
D. Are you prepared to bind every subcontractor, supplier, and vendor, to the terms of the contract as far such terms are applicable to each subcontractors work?	Yes	No
E. Acknowledge inclusion in the bid of all Addenda?	N/A	Yes No
F. Acknowledged Receipt of Pre-Bid Clarifications (RFI) Submitted?	N/A	Yes No
G. Acknowledge inclusion in the Bid of all Allowances? 1. 2. 3. 4.	N/A	Yes No
H. Acknowledge inclusion in the Bid of all Alternates? 1. 2. 3. 4.	N/A	Yes No
I. Acknowledge that you are required to comply with the SWPPP.	Yes	No
J. Acknowledge that you are required to comply with the PM-10	Yes	No

**Contractor's Initial** \_\_\_\_\_

3.03 SCOPE OF WORK

A. Are the plans and specifications clear and understandable?	Yes    No
B. Are there any items that need to be identified or require clarification?  If yes, please identify item.  1.  2.  3.  4.  5.  6.	Yes    No
C. Is (are) the cost(s) for the above items (as applicable) included in your proposal items?	Yes    No
D. Review bid alternatives (if applicable)  1.  2.  3.	N/A    Yes    No
E. Are you proposing any substitutions?  If yes, please identify item.  1.  2.  3.  4.  5.  6.  7.  8.  9.	N/A    Yes    No

**Contractor's Initial** \_\_\_\_\_

3.04 Are you proposing any VALUE ENGINEERING? (describe)

1. Add / Deduct
2. Add / Deduct
3. Add / Deduct
4. Add / Deduct
5. Add / Deduct
6. Add / Deduct
7. Add / Deduct
8. Add / Deduct
9. Add / Deduct
10. Add / Deduct
11. Add / Deduct
12. Add / Deduct
13. Add / Deduct

VALUE ENGINEERING TOTAL \$ \_\_\_\_\_

BASE BID \$ \_\_\_\_\_

PROPOSED REVISED TOTAL \$ \_\_\_\_\_

**Contractor's Initial** \_\_\_\_\_

3.05 SCHEDULE

- A. Can you meet the construction duration stipulated in the Contract? Yes No
- B. Can you meet Submittal Schedule Deadlines? Yes No
- C. Will you provide Cost and Manpower loading for your construction schedule activities to within the required seven (7) calendar days, per the Contract?  
(Section 01 31 00 – Construction Schedule) Yes No
- D. It is understood the Project schedule is critical. Can you accelerate any and all schedule activities if the requirement occurs? Yes No

- E. If not, what must change and why?

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- F. Identify critical materials, deliveries and dependencies (long lead), including Owner Furnished items that could affect the completion of your work.

1. 

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2. 

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3. 

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4. 

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5. 

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6. 

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7. 

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- G. You have reviewed the “Time for Completion” set forth in the Agreement, and you further understand the County MAY assess liquidated damages if you fail to complete this Project within same. You further understand any delays caused by you or your subcontractors WILL require your company to accelerate the Work upon written direction by the County, in order to complete this Project on time, as stipulated in the Agreement.

Yes No

- H. You agree that failure to meet the completion date is just cause for the County to assess and retain Liquidated Damages in accordance with the Contract Documents. Yes No

**Contractor's Initial** \_\_\_\_\_

3.05 CONTRACTOR COMMENTS / SUGGESTIONS

- A. \_\_\_\_\_
- B. \_\_\_\_\_
- C. \_\_\_\_\_
- D. \_\_\_\_\_
- E. \_\_\_\_\_
- F. \_\_\_\_\_
- G. \_\_\_\_\_
- H. \_\_\_\_\_

3.06 AGREEMENT

- A. Contractor agrees that the information contained herein is part of your contractual obligations. Your signature acknowledges your agreement to perform all work discussed herein, and that costs for all work are included in your proposal. The foregoing information is true and accurate, and I am authorized to sign as an officer of the company I am representing.

Company Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

3.07 WITNESS

- A. Owner

Company Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

- B. Architect

Company Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

**END OF SECTION**

**Contractor's Initial** \_\_\_\_\_

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## SECTION 01 10 00

### SUMMARY OF WORK

#### PART 1 – GENERAL

##### 1.01 PROJECT DESCRIPTION

- A. The project consists of the major renovation of an approximately 75,071 SF existing three-story, tilt-up concrete building and associated site improvements to accommodate the County of San Bernardino's Information Technologies Department (ITD.) The project scope is primarily comprised of an interior tenant improvement including the demolition of all built elements excluding core elements such as the vertical circulation, mechanical, electrical rooms, and restrooms. The scope of work includes limited sitework demolition and improvements.
- B. The Scope of Work and all related General Notes, Construction Notes on the drawings and specifications for the project has been included as a part of these Contract Documents. Crews must be staffed as necessary to meet the bid schedule and will be finalized in the General Contractor's submitted and approved project schedule.

##### 1.02 CONTRACT METHOD

This project is a general contract / hard bid. Contract for this bid will be awarded to the lowest responsive and responsible lump sum bidder for the **ISD Acquisition & Improvements Project**.

##### 1.03 DESCRIPTION OF WORK

The scope of work for this contract includes, but is not limited to, those areas described within this section, and all sections listed within the Technical Specification. The Work to be performed by the General Contractor is outlined in this Section and includes all Work shown on the Drawings, Construction Notes, General Notes, Technical Specifications, and Scope of Work Summaries.

- A. The General Contractor shall provide and maintain safe access for all pedestrian and vehicle traffic during the course of the project.
- B. The project is located in the Colton City Limits. Compliance with the Noise Ordinance and allowable working hours will be enforced.
- C. The General Contractor is responsible to maintain, repair, and/or replace the tree protection for the trees scheduled to remain.
- D. The General Contractor is responsible for all traffic, pedestrian, construction and regulatory signage as requires or necessary to meet all governing regulatory requirements.
- E. The General Contractor shall maintain an adequate labor work force, as required on a daily basis, to properly clean up all the debris associated with the General Contractor's work. All rubbish/debris resulting from the General Contractor's operation will be deposited directly into "dumpster type" rubbish containers. Removal and disposal of full "dumpster type" rubbish containers will be the responsibility of the General Contractor, and receipts provided for the Project's waste diversion program. All efforts shall be made to recycle those items that can be. All recycled items must be properly documented and a receipt provided to the Owner Representative for their waste diversion program.
- F. The Bid Drawings and Specifications indicate the scope of the Work in terms of the design concept, the dimensions of the Work, and the structural elements of construction. The Bid Drawings and Specifications do not necessarily indicate or describe all Work required for the full performance and completion of the Work. The General Contractor shall be solely responsible for the inclusion of adequate amounts in the bid price to include all items indicated, described, implied, or necessary in order to produce a completed Project. Decisions of the Owner Representative as to the items of Work included within the scope of



these Drawings and Contract Documents shall be final and binding on the Bid Category/General Contractor's.

- G. The Work to be performed under this Contract shall include the furnishing of all tools, equipment, materials, hardware, accessories, supplies, and fabricated or manufactured articles for the Work, including all guarantees and warranties. The Work shall also include the furnishing of all packaging, transportation, trucking, fuel, freight, delivery and services; obtaining of permits, licenses, insurance and bonds, payment of all applicable taxes, and all storage and demurrage costs. The Work also includes furnishing of all project administration, supervision, surveying and layout, engineering, detailing, shop drawings and submittals; as well as the provision of scaffolding, temporary bracing and shoring, temporary stairs, ladders and other access aids, all Cal/OSHA-required safety measures, and all other operations and miscellaneous services and appurtenances required for the fulfillment of the Contract, and completion of the indicated, described, or implied scope of Work in strict accordance with the Contract Documents, as well as their intent in describing the scope of a completed Project.

#### 1.04 WORK INCLUDED IN THE SCOPE OF THE CONTRACT DOCUMENTS

- A. All Work under this Contract shall be performed in strict accordance with the Technical Specification listed in the Table of Contents, as these Sections relate specifically to the Work of the General Contractor. The General Contractor shall carry out any related Work, which may be described in all Sections of the Specifications relative to its Work, and shall coordinate its Work with the Work of other trades in accordance with all Sections of the Technical Specifications, and all other requirements of the Contract Documents.
- B. Unless otherwise specified, the Owner will provide and pay for all Independent-testing labs services required for this project during normal working hours and days as defined in the Division 0 and 1 of the project specification. The costs of any and all special inspections, re-inspections and/or Overtime charges billed as additional costs to the Owner due to the shift in the normal working hours or days to meet a modified schedule, re-inspection caused from inspection failure shall be paid by the issuance of a deductive change order from this contract.
- C. Any and all off-site material and/or product fabrication testing and/or inspection required by the contract documents, regulatory agencies, State or Local codes and regulations in excess of a 50 mile radius from the County's site, related to this contract, shall be paid for by the General Contractor. The General Contractor shall assume the responsibility to pay for these additional costs by the issuance of a deductive change order from this contract.
- D. The General Contractor shall provide and/or furnish the following general provisions:
1. By submitting this Bid, The General Contractor confirms that they have familiarized themselves with the conditions of the site and that they have made their own estimates regarding the facilities and the difficulties, which may arise in connection with the execution of the Work.
  2. The General Contractor shall provide sufficient equipment, manpower and/or overtime, at no increase to Contract Price, to maintain the rate of installation required to accommodate the Project Construction Schedule.
  3. The General Contractor shall provide and/or furnish the following general provisions:
    - a. The General Contractor shall provide a **detailed Project Approach** for review by the Owner Representative prior to the first (1<sup>st</sup>) progress payment.
    - i. This shall be a written statement and shall describe how the General Contractor plans on approaching this project to ensure a safe and successful completion. The approach shall include but not limited to...
      - a). Their approach to safety (Refer to Section 01 44 40 – Site Safety) each day, as well as instill safety in their employees.

- c). Their approach to timely and properly communicate to the construction manager, staging, hoisting, the timely ordering of materials, delivery and stocking.
- c). Their approach to ensure proper manpower to complete activities on-time.
- d). Their approach to timely review of respective scope, coordination with other trades, layout, potential issues, etc. as not to delay yourself or other trades.
- e). How often will a project manager and/or general superintendent visit the project to ensure contract compliance.
- b. The General Contractor shall modify, adjust and perform scheduled work when and as directed by Owner Representative.
- c. The project is an alcohol-free and drug-free project. Any persons found using alcohol or drugs on the site or who are suspected of being under the influence of alcohol or drugs will be immediately removed from the jobsite.
- 4. Prior to any release of retainage, The General Contractor shall perform specified Owner personnel instruction, execute all guarantee/warranty forms, and all other Contract Document specified close-out items, which shall require approval by the Owner Representative, the City and the Engineer, or those parties designated as their representative agents.
- 5. The General Contractor shall perform the Work in a safe and proper manner and he will properly guard its Work and areas affected by its Work to prevent any person or persons from being injured by it or by the condition of the site or project, and he will in all respects comply with any and all provisions of the law and ordinances referring to such Work, and of local ordinances relating to the maintenance of danger signals, barriers, lights and similar safeguards respecting falling materials and in and about all of the Work and adjacent areas where the same are required.

***In the event of accidents or incidents of any kind, The General Contractor shall furnish Owner and/or Owner's Representative with copies of all accident or incident reports. Reports shall be sent without delay and at the same time they are forwarded to any other parties. The General Contractor shall notify Owner's Representative immediately of any accident and/or incident. The General Contractor shall comply with all OSHA related requirements.***

If, in the judgment of the Owner's Representative, the General Contractor fails to comply with such orders or directions within **48 hours** (including weekends and holidays) of sending of a written safety notice(s) to the General Contractor, the Owner may; either terminate this contract (with the same rights as set forth in the general conditions) or stop the Work of the General Contractor until the General Contractor complies with the aforesaid orders or directions (The General Contractor's remaining liable for performance under this contract and for all damages arising out of such Work stoppage) or the Owner's Representative may take all such action as may be necessary to make the General Contractor's Work comply with such orders and directions and charge the General Contractor for all costs incurred. Failure of the Owner's Representative or any such safety engineer or inspector to issue any such orders or directions to the General Contractor shall not relieve the General Contractor from any of its obligations under this contract.

#### 1.05 COMMENCEMENT AND COMPLETION OF THE WORK

- A. In accordance with the provisions of the Contract Agreement, the General Contractor shall begin the Work on the date specified in the written Notice to Proceed from the County, and

shall complete all of the Work included in the Contract within the time specified in said Notice. Time stated for completion shall include all closeout requirements, completion of final punch list, and final clean up.

- B. The Bid amount requests the General Contractor to submit its most competitive Bid Price for the Work on the basis of the Bid Document.

#### 1.06 ORDER OF THE WORK

The Work shall be carried on at such places on the Project and also in such order or precedence as may be found necessary to expedite completion of the Project. After Work has begun on any portion of a designated part of the Project, it shall be carried forward to its final completion as rapidly as practicable. The order and time to complete the Work shall conform, in general, with the requirements of the Project Construction Schedule.

#### 1.07 THE GENERAL CONTRACTOR'S USE OF PROJECT SITE / DELIVERY AND STAGING OF MATERIALS

- A. The General Contractor's use of the Project site shall be limited to its construction operations, including on site storage of materials and equipment, on site fabrication facilities, and field offices.
- B. Staging and storage of materials on site by The General Contractor shall primarily be permitted in the areas approved in writing and scheduled in advance by the Owner Representative.
- C. The General Contractor shall be responsible for the protection of its own Work during construction and protection of its own material during delivery, unloading, hoisting, while in storage, until accepted by the Owner Representative.
- D. Material/Personnel Hoisting:
  - 1. The General Contractor shall include all hoisting, rigging and final placement required for all materials and equipment necessary for the proper completion of the work.
  - 2. The General Contractor will submit for approval his proposed scheme for the hoisting of all major equipment, including any required shop drawings, sketches and/or load distribution diagrams so as to allow hoisting activities to be coordinated and approved with other The General Contractor's field operations.
  - 3. The General Contractor shall schedule all material hoisting with the Owner's Representative a minimum of 48 hours prior to the time requested in order to coordinate the use of the designated hoisting area.
- E. The General Contractor shall deliver materials to the jobsite in order to provide for the proper execution of the Work in a continuous, uninterrupted fashion unless scheduled otherwise by the Owner's Representative. Material deliveries shall be scheduled in coordination with the Owner's Representative and the General Contractor
- F. If the General Contractor's materials are stockpiled in unapproved areas or creating interference or obstruction with the Work of others, or if they are overloading the structure then, at the discretion of the Owner's Representative, the General Contractor shall be required to relocate these materials at the General Contractor's expense. If materials are not relocated in the specified time, the Owner reserves the right to move such materials and back charge the General Contractor.

#### 1.08 OWNER USE OF THE PROJECT SITE

The Owner and their authorized representatives shall be allowed access to the Project site at all times during the period of construction.

#### 1.09 SURVEY OF ADJACENT SITE CONDITIONS

- A. Prior to commencement of Work, **it is the responsibility of the General Contractor to**

**initiate and coordinate a site survey.** The General Contractor shall jointly survey the site, and all other pertinent items with the Owner and/or the Owner Representative, noting and recording existing damage such as cracks, sags, and other damage to on-site.

- B. This record shall serve as a basis for determination of subsequent damage to these items due to the General Contractor's operations.
- C. Existing damage observed shall be marked and the official record of existing damage shall be signed by the parties and submitted to the Owner's Representative prior to start of Work.
- D. Damage to the site, and other items not noted in the original survey but subsequently observed shall be reported immediately by the General Contractor to the Owner's Representative.
- E. Should the General Contractor not schedule / coordinate this survey, any damage noted to adjacent finishes shall be repaired by the General Contractor at the General Contractor's expense.

1.010 PROTECTION OF EXISTING UTILITIES AND FACILITIES

- A. The General Contractor shall provide adequate protection, as required, of adjacent materials and adjacent properties.
- B. The General Contractor shall be solely responsible for any damage to public property, private property, or to utilities caused by the General Contractor's operations. Any such damage shall be corrected by the General Contractor in a manner approved by the damaged party, and/or the Owner, at no additional cost to the Owner.
- C. The General Contractor shall, at all times, keep the project and areas continuously clean and free from accumulation of the waste materials or debris resulting from the General Contractor's operations, in a manner and to the extent acceptable to the Owner's Representative and the Owner.

1.011 CORRESPONDENCE

All correspondence, submittal, requests, questions, shop drawings, etc., between the General Contractor and the Owner, Engineer, Consultants or any other Project related staff shall be directed through the Owner's Representative.

**END OF SECTION**

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## SECTION 01 21 00

### ALLOWANCES

#### **PART 1 – GENERAL**

##### 1.01 SECTION INCLUDES

- A. Allowances which the General Contractor shall provide for designated construction activities in the Work and in this bid.

##### 1.02 RELATED DOCUMENTS

- A. The Conditions of the Contract and other section of Division 01 apply to this section as fully as if repeated herein.

##### 1.03 DESCRIPTION OF REQUIREMENTS

- A. Definitions and Explanations: Certain requirements of the construction related to each allowance are indicated and specified. The allowance has been established by the Owner and represents selection by the Owner for designated portions of the Work specified and shown.
- B. Types of allowance scheduled herein for the Work include lump sum cash allowances. Include all allowances in Contract sum, and identify all allowances in Schedule of Values as separate line items.
- C. Selection and Purchase: At earliest feasible date after award of contract, advise the Construction Manager of scheduled date when final selection and purchase of each product or system described by each allowance must be accomplished in order to avoid delays in performance of the Work.
  - 1. Establish date by which the General Contractor must enter into contract and coordinate with sub-contractor responsible for work defined by allowance.
  - 2. Establish date by which final list of products must be established for purchase of products and systems as specifically selected by the Owner.

##### 1.04 DEFINITIONS AND DESCRIPTION OF REQUIREMENTS

- A. Cash Allowance Criteria
  - 1. The Allowance is used only as directed by the Owner.
  - 2. The Allowance is used exclusively for the Owner's purposes and for the defined Scope of Work.
  - 3. The General Contractor will prepare detailed breakdown of all costs associated with the work defined for the allowance. These amounts will be charged against the Allowance by Change Order, based on final detailed payment receipts and back-up as required by Architect and Construction Manager, and will include all direct costs of work performed under the defined work scope.
    - a. The General Contractor shall obtain quotes for equipment from three separate vendors and present to Owner for consideration and selection.
  - 4. The General Contractor shall include in the base bid contract amount all cost of coordination, supervision, bond costs, overhead and profit, supervision, installation and all indirect project costs associated with the work defined. Where allowance amount is not exceeded, no general contractor costs will be permitted to be charged against the allowance amounts specified below.
    - a. At project closeout, unused Cash Allowance amounts shall be credited to the Owner by Change Order.

- b. Changes that exceed the amount of each allowance will be processed as a Change Order per Contract Documents.

**B. Material and Labor Allowance Criteria**

1. Applies to all material and labor allowances identified in the contract documents.
2. The Allowance is used only as directed by the Owner.
3. The Allowance is used exclusively for the Owner's purposes and for the defined Scope of Work.
4. The General Contractor will prepare detailed breakdown of all costs associated with the work defined for the allowance. These amounts will be charged against the Allowance by Change Order, based on final detailed payment receipts and back-up as required by Architect and Construction Manager, and will include all direct costs of work performed under the defined work scope.
  - a. The General Contractor shall obtain quotes for equipment from three separate vendors and present to Owner for consideration and selection.
5. The General Contractor shall include in the base bid contract amount all cost of coordination, supervision, bond costs, overhead and profit, supervision, installation and all indirect project costs associated with the work defined. Where allowance amount is not exceeded, no general contractor costs will be permitted to be charged against the allowance amounts specified below.
  - a. At project closeout, unused Material and Labor Allowances shall be credited to the Owner by Change Order based on the cash value established per Section 1.04.B.4.
  - b. Changes that exceed the amount of each allowance will be processed as a Change Order per Contract Documents.

**PART 2 – PRODUCTS**

NOT USED

**PART 3 – EXECUTION**

**3.01 SCHEDULE OF CASH ALLOWANCES**

Included in the Total Bid Amount are the Allowances identified below. Items covered by Allowances shall be provided for such amounts and by such persons or firms as the Owner may direct.

**Building and Site Work**

**ALLOWANCE 01 – Demolition:** **\$ 25,000**

**ALLOWANCE 10 – Miscellaneous Specialties/General Construction:** **\$ 50,000**

Contractor shall itemize the allowances listed above on the bid form in the designated areas for any additional effort, over and above contract work due to existing conditions, obstructions or unforeseen items encountered which are not readily discernible prior to construction. Allowance will also be used at the Owner's discretion for any required supplemental work.

**END OF SECTION**

## SECTION 01 23 00

### ALTERNATES

#### PART 1 – GENERAL

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 DESCRIPTION

A. Work Included: Provide alternative bid proposals as described in this Section.

B. Procedures:

1. Provide alternative proposals to be added to or deducted from the amount of the Base Bid if the Owner accepts the corresponding change in scope.
2. Include within the alternative bid prices all costs, including labor, materials, installations, and fees.
3. Show the proposed alternative amounts opposite their proper description on the Contractor's Proposal.

C. Acceptance or Rejection:

1. Acceptance or rejection of Alternate Bids is subject to Owner's discretion. The Owner reserves the right to award any or none of the Alternate Proposal items as the Owner may deem to be in its best interests and without regard to the order in which such items are listed in the Proposal.

END OF SECTION



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## SECTION 01 25 00

### SUBSTITUTION PROCEDURES

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SUMMARY

- A. Section includes administrative and procedural requirements for product substitutions.
- B. These procedures do not apply to section(s) that are marked NO SUBSTITUTIONS.

##### 1.03 STANDARDS AND REFERENCES

- A. Definition: A substitution is a proposed change by the Contractor in products, materials, equipment and/or methods of construction from those required by the Contract Documents.
- B. Requirements:
  - 1. Comply with the Industry Standards and References as set forth in the specific Sections.
  - 2. For products specified by stating “or other approved” or “or approved equal” or other such wording on drawings or within specifications sections, submit a request for substitutions for any product or manufacturer which is not specifically named.

##### 1.04 QUALITY ASSURANCE

- A. The Bidder represents that in making a legitimate, authorized formal request for substitution:
  - 1. A thorough investigation has transpired concerning the proposed product, and it has been determined that it is equal to or superior in all respects to that specified.
  - 2. The same warranties or bonds and guarantees will be provided as for that specified.
  - 3. Installation of the accepted substitution will be coordinated into the work; and such changes to in-place work, ordered materials and products, or other work to be in progress prior to installation of the requested substitutions, will be performed without any additional cost to the OWNER.
- B. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

##### 1.05 SUBMITTALS

- A. Provide in accordance with Section 01 33 00
- B. Deadlines:
  - 1. Pre-Bid: Submittals are due (14) Calendar Days prior to the Published Bid Deadline.
  - 2. After Award of Contract:
    - a. Substitution requests will be considered to provide competition or only if the specified product or system has gone out of production prior to bidding, or specified product or system has been deemed illegal or dangerous by governing agencies having jurisdiction over this project.
    - b. Provide within thirty (30) calendar days after the Notice of Award in accordance with Section 01 33 00; formal requests will be considered for substitutions of products in place of those specified.

- C. Substitution Requests: Submit three (3) hard copies and an electronic version of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Substitution Request Form: Use Section 01 25 01.
  2. Documentation: Show compliance with requirements for substitutions and the following is applicable:
    - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
    - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Included annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any from the Work specified.
    - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    - e. Samples, where applicable or requested.
    - f. Certificates and qualification data, where applicable or requested.
    - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
    - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
    - i. Research reports evidencing compliance with current California Building Code.
    - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
    - k. Cost information, including a proposal of change, if any, in the Contract Sum.
    - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
    - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
  3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 7 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- a. Forms of Acceptance: Change Order.
- b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

## **PART 2 – PRODUCTS**

### **2.01 SUBSTITUTIONS**

#### **A. Substitutions of Equipment and Materials During Bidding**

1. Requests for Substitutions: The Bidder shall make Requests for Substitution on the County's Requests for Substitution form included in the Bidding Documents. Such requests shall comply with the requirements of the Bidding Documents, including without limitation, the Plans and the Specifications, without limitation to the other requirements of the Request for Substitution form, requests for Substitutions shall include:
  - a. A description of the material, equipment or other work that is to be replaced or eliminated by the Substitution;
  - b. A description of any other changes to the Work, Existing Improvements, the Site or the work of Separate Contractors that would be necessary if the proposed Substitution were incorporated as part of the Work;
  - c. A statement that the bidder accepts responsibility for the inclusion in its Bid of all of the costs of implementing the Substitution, including, without limitation, the costs of any related changes to the Work, Existing Improvements, the Site or the work of Separate Contractors;
  - d. All the drawings, performance and the test data and other information necessary for an evaluation of the Substitution by the County, Architect and County Consultants; and
  - e. A statement that the Bidder understands and agrees that if the Substitution is not approved and the Bidder submits a Bid, Bidder will provide the Work as specified in the Bidding Documents without such Substitution.
2. The burden of proof of the merit of a proposed Substitution is entirely upon the Bidder requesting the Substitution.

- B. After award of Contract, Architect will consider formal requests from the Contractor for substitution of products in place of those specified only in case of product unavailability or other conditions beyond the control of Contractor.

Requests for Substitutions made after the award of Contract shall conform to the requirements for Substitutions of Equipment and Materials during Bidding.

- C. Should a substitution be approved under the foregoing provisions and subsequently prove to be defective or otherwise unsatisfactory for the intended use or function, Contractor shall, without cost to Owner and without obligation on the part of the Architect replace the substitute with the product, material, or equipment originally specified, if available, or another substitution conforming to the above requirements.

## **PART – 3 EXECUTION**

NOT USED

**END OF SECTION**

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SECTION 01 25 01

**SUBSTITUTION REQUEST FORM**

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Project: \_\_\_\_\_ Substitution Request Number: \_\_\_\_\_  
\_\_\_\_\_  
To: \_\_\_\_\_ From: \_\_\_\_\_  
\_\_\_\_\_  
Date: \_\_\_\_\_  
\_\_\_\_\_  
A/E Project Number: \_\_\_\_\_  
Re: \_\_\_\_\_ Contract For: \_\_\_\_\_  
\_\_\_\_\_

---

Specification Title: \_\_\_\_\_ Description: \_\_\_\_\_  
Section: \_\_\_\_\_ Page: \_\_\_\_\_ Article/Paragraph: \_\_\_\_\_  
\_\_\_\_\_

---

Proposed Substitution: \_\_\_\_\_  
Manufacturer: \_\_\_\_\_ Address: \_\_\_\_\_ Phone: \_\_\_\_\_  
Trade Name: \_\_\_\_\_ Model No.: \_\_\_\_\_  
Installer: \_\_\_\_\_ Address: \_\_\_\_\_ Phone: \_\_\_\_\_  
History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old  
Differences between proposed substitution and specified product: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
☐ Point-by-point comparative data attached — REQUIRED BY A/E

---

Reason for not providing specified item: \_\_\_\_\_  
\_\_\_\_\_

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Similar Installation:  
Project: \_\_\_\_\_ Architect: \_\_\_\_\_  
Address: \_\_\_\_\_ Owner: \_\_\_\_\_  
\_\_\_\_\_ Date Installed: \_\_\_\_\_

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Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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Savings to Owner for accepting substitution: \_\_\_\_\_ (\$ \_\_\_\_\_).

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Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] \_\_\_\_\_ days.

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Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ \_\_\_\_\_

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The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
  - Same warranty will be furnished for proposed substitution as for specified product.
  - Same maintenance service and source of replacement parts, as applicable, is available.
  - Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
  - Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
  - Proposed substitution does not affect dimensions and functional clearances.
  - Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
  - Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.
- 

Submitted by: \_\_\_\_\_

Signed by: \_\_\_\_\_

Firm: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Telephone: \_\_\_\_\_

Attachments: ☐

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#### A/E's REVIEW AND RECOMMENDATION

- ☐ Approve Substitution - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures.
- ☐ Approve Substitution as noted - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures.
- ☐ Reject Substitution - Use specified materials.
- ☐ Substitution Request received too late - Use specified materials.

Signed by: \_\_\_\_\_ Date: \_\_\_\_\_

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#### OWNER'S REVIEW AND ACTION

- ☐ Substitution approved - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures. Prepare Change Order.
- ☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures. Prepare Change Order.
- ☐ Substitution rejected - Use specified materials.

Signed by: \_\_\_\_\_ Date: \_\_\_\_\_

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Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ A/E

**END OF SECTION**

## SECTION 01 26 00

### CHANGE ORDER PROCEDURES

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. This Section specifies administrative and procedural requirements for handling and processing Change Orders and other modifications to the Contract.

##### 1.02 WORK DIRECTIVE CHANGE PROPOSAL REQUEST

- A. County Initiated Field Work Directive Change Proposal Requests: Proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time will be issued by the County's Representative, with a detailed description of the proposed change and supplemental or revised Drawings and Specifications, if necessary, under a Field Work Directive.
1. Unless otherwise indicated in the Field Work Directive (FWD), within seven (7) days of receipt of the (FWD), submit to the County's Representative for the County's review an estimate of cost necessary to execute the proposed change.
    - a. Include a list of quantities of products to be purchased and unit costs, along with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities. Furnish a complete labor breakdown, labor rates, man hours by trade and level, etc.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Submit a proposed schedule and narrative statement indicating the effect the proposed change in the Work will have on the Contract Time.
- B. Contractor Initiated Field Work Directive Proposal Requests: When latent or other unforeseen conditions require modifications to the Contract, the Contractor **MUST** notify the Construction Manager immediately at the time of the condition to allow Construction Manager to determine the best course of action. Contractor shall also notify the Construction Manager in writing the same day and request a Field Work Directive change from the County's Representative whereupon the (FWD) designate a Potential Change Order (PCO) to it for tracking purposes.
1. Include a narrative statement outlining reasons for the change, including comprehensive reference to the section(s) of the Contract Documents, which justify Contractor's entitlement to the change, and describe the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Price and a proposed schedule indicating the effect on the Contract Time.
- C. Contractor shall refer to the Division 00 – General Conditions and Supplemental Conditions for additional relevant information.
- D. All Contractor Change Order Requests (COR) shall be submitted on the form provided in Section 01 99 99 – FORMS. **No other form will be accepted.**

##### 1.03 CHANGE ORDER PROCEDURES

- A. Upon the County's approval of the Proposed Change Order, the County's Representative will issue a Change Order for signatures of the Architect, Construction Manager, and Contractor and submit to the School Board for formal approval. Upon board approval, the change order shall be placed on the trade contractor's schedule of values for payment.



**PART 2 – PRODUCTS**

NOT USED

**PART 3 – EXECUTION**

NOT USED

**END OF SECTION**

NOT FOR BID

## SECTION 01 29 76

### APPLICATION FOR PAYMENT

#### **PART 1 – GENERAL**

##### 1.01 DESCRIPTION

- A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment, including preparation and submittal of a Schedule of Values (SOV).

##### 1.02 SCHEDULE OF VALUES

- A. Contractor shall review Article 20 of the General Conditions and Supplemental Conditions for additional applicable information.
- B. Submit a Schedule of Values, for review and approval by the County Representative, within Thirty (30) days after issue of NTP unless noted otherwise in the schedule section of Division 01.
- C. Phased Work: Where the Work is separated into phases, the SOV shall represent this phased work and shall follow the same format and content as noted herein.
- D. Format and Content: The Schedule of Values shall be submitted to the County's Representative.
  - 1. Contractor shall review Article 20 of General Conditions and Supplemental Conditions for additional applicable information.
  - 2. Round amounts off to the nearest whole dollar; the total shall equal the Contract Sum.
  - 3. For each part of the Work where an Application for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed, provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
- E. Margins of Cost: Show line items for indirect costs, and margins on actual costs, only to the extent that such items will be listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete including its total cost and proportionate share of general overhead and profit margin.
- F. Schedule Updating: Change Orders shall not be included in Applications for Payment until the respective modification in Contract Sum has been included in an executed Change Order.

##### 1.03 APPLICATIONS FOR PAYMENT

- A. Requirements: Refer to Article 20 of the General Conditions and Supplemental Conditions for additional applicable information.
- B. Monthly Progress Procedure: The Construction Manager will produce and process the billing each and every month.
  - 1. During the first of each month, during the progress of the portion of the Work for which payment is being requested, the Construction Manager will forward a draft billing for the Prime Contractor's approval indicating the percentages representative of the work installed. The Prime Contractor shall affix comments and/or initials and return draft billing.
    - a. Material invoices, evidence of equipment purchases and rentals, along with other support and details of cost, may be required to be submitted to the Owner from time to time.

- b. Draft billings not returned to the Construction Manager by the requested time will be assumed "correct as noted".
  2. The Construction Manager will then forward one formal billing to the Prime Contractor.
    - a. Contractor shall photo copy to produce a total of four copies wet sign all four and return to the Construction manager by the requested date.
    - b. Along with the returned billing, contractor shall provide all the necessary attachments in accordance with Article 20 of the General Conditions and Supplemental Conditions.
    - c. Failure to return the billing or applicable attachments within the time frames specified by the Construction Manager will result in processing no sooner than the next application period.
  3. Upon receipt of the complete billing submittal, the Construction Manager will coordinate all the necessary signatures and submit to the owner for payment process.
    - a. All billing requests are submitted to the County of San Bernardino for check issuance.
    - b. Checks are returned to the owner for distribution
- C. Application for Payment at Substantial Completion: Upon the Contractor satisfying the requirement per Article 22 of the General Conditions and Supplemental Conditions, inclusive of the following as noted below, Contractor shall request an Application for Payment.
  1. A submitted punch list from trade contractor to Construction Manager and Architect for review. Upon receipt, Architect, Construction Manager, Owner, and IOR shall walk and add to the list if necessary. Contractor shall provide completion dates to each listed item
  2. Warranties and maintenance agreements are submitted and approved by the Architect
  3. Test records and as-builts are complete and approved by Architect
  4. Meter readings (if required).
  5. Operation and Maintenance Manuals have been submitted and approved by the Architect
  6. Conditional Waiver and Release for current progress payment
  7. Unconditional Waiver and Release for prior progress payment
  8. Consent of Surety letter acknowledging payment
  9. No filed stop notices
  10. No Labor compliance issues
  11. No lawsuit.
- D. Final Payment Application:
  1. Refer to Article 22 of the General Conditions and Supplemental Conditions.

## **PART 2 – PRODUCTS**

NOT USED

## **PART 3 – EXECUTION**

NOT USED

**END OF SECTION**

## SECTION 01 31 00

### CONSTRUCTION SCHEDULES

#### PART 1 – GENERAL

##### 1.01 SUMMARY

A. This Section includes administrative and procedural requirements for a successful execution of the Work, as well as documenting the progress of construction during performance of the Work, which includes the following:

1. Notice to Proceed
2. Milestones / Liquidated Damages
3. Construction Schedule
4. Submittals
5. Coordination Drawings
6. Procurement / Fabrication / Delivery
7. Daily Work Reports

B. Related Sections include the following:

1. General Conditions
2. Supplemental Conditions
3. All of Division 01 – General Requirements

##### 1.02 NOTICE TO PROCEED

A. NTP begins the start of administrative, early planning / coordination, submittals and procurement and fabrication, delivery and the start of construction.

##### 1.03 MILESTONES

- A. Each trade shall be familiar with their respective deliverable(s) and the associated day following the date of the Notice to Proceed (NTP) that it is due. It is the sole responsibility of the contractor to **properly plan and execute** to ensure their respective deliverable / milestone is submitted on time.
- B. Any deliverable missed, contractor shall be assessed the associated liquidated damage per day until the complete package or required contract obligation has been received.

##### 1.04 CONSTRUCTION SCHEDULE

- A. The "Project Construction Schedule" is to be submitted by the General Contractor. It shall be composed of tentative starting dates and fixed durations for **major** activities of work on the project. The General Contractor and Sub-Contractors are responsible for complying with the requirements of the schedule, once approved, initiating and coordinating their respective work as necessary in the proper sequencing of the Work.
- B. General Contractor to provide Manpower information for each respective activity and activities not shown but necessary. The manpower shall represent the crew size required each day to fully execute the trade's scope of work. This information is required within 10 day of NTP issuance.
- C. CONTRACTOR must coordinate all work with all other contractors on the project through the CONSTRUCTION MANAGER'S Project Superintendent in order to complete each activity of

their work within the fixed durations assigned to same as shown on the "PROJECT CONSTRUCTION SCHEDULE".

- D. Schedule start dates as shown on the PROJECT CONSTRUCTION SCHEDULE are referred to as "tentative" only to the affect that said dates will be continually adjusted either forward or backward by the CONSTRUCTION MANAGER as the project progresses. Upon receipt of 48 hours advanced notice by the CONSTRUCTION MANAGER to begin work on an activity, CONTRACTOR must properly man and perform the work of said activity and complete same within the noted number of consecutive working days or less assigned to said activity in the PROJECT CONSTRUCTION SCHEDULE.
- E. CONTRACTOR is expected to continually monitor all phases of the project field construction progress in order to insure that CONTRACTOR'S work is properly implemented into the overall project improvements.
- F. CONTRACTOR is expected to provide properly trained and skilled mechanics in adequate numbers and equipment needed and/or required in order to properly and efficiently complete all work activities per the schedule. Should CONSTRUCTION MANAGER have reason to believe at any time that CONTRACTOR is not providing an adequate workforce armed with the proper materials and/or equipment, CONSTRUCTION MANAGER shall give CONTRACTOR written notice of same. Activity Manpower loading submitted shall in no way limit the responsibility of the CONTRACTOR to perform to the fixed duration requirements of the PROJECT CONSTRUCTION SCHEDULE.
- G. The time for total project completion shall be within 365 Calendar Days from the Notice to Proceed. This total time of completion includes 10 Work Days for Weather Impacts and 20 Work Days for Commissioning. The Weather Impacts and Commissioning activities are for the sole use of the OWNER. The CONSTRUCTION MANAGER will use established contract fixed durations to prepare and update a Critical Path Method Schedule (C.P.M.) by building and site. This schedule will be the basis of weekly production review meetings and the method of measuring each CONTRACTOR'S performance and impact on dependent CONTRACTORS, required cure, and the assessment of liquidated damages.
- H. Recovery Plan
  - 1. If at any time, the contractor is behind schedule by more than three days for any stage of Work, based on the updated Contract Schedule after incorporating all approved time extensions, Contractor shall submit to the OWNER's Representative within five (5) days of notification of such delay, a "recovery plan". The recovery plan shall be based on proposed revisions to Contract Schedule and shall show how Contractor intends to bring the Work back on schedule. Recovery plan shall also include a written description of how the measures that Contractor intends to take without additional cost to the OWNER will regain schedule compliance. The recovery plan activities shall be identified according to their relationship to activities.
  - 2. Should Contractor fail to submit and execute such recovery plan, the OWNER shall have the option to direct Contractor to employ any or all measures that the OWNER may deem fit to regain schedule compliance without additional cost to the OWNER.
  - 3. Recovery plan submitted by Contractor, upon acceptance by the OWNER's Representative, shall be incorporated into the Contract Schedule during the next update.
  - 4. Contractor will be required to submit a recovery plan for each activity that is more than three day or more behind schedule.
  - 5. Should Contractor dispute the determination of the OWNER's Representative regarding the status on a contract delay, such dispute shall not relieve him/her of the responsibility to comply with the requirements of this Section and other related Sections until the dispute is resolved per Contract terms.

I. Inclement Weather:

1. The agreement between the OWNER and Contractor indicates the number of calendar days of Contract time for the Work. Within the stipulated Contract Time, the Bid Schedule, included in the bid documents, includes weather days in the project duration.
2. The number of weather related days have been built into the critical path. The project owns the allowable rain days. As the number of approved inclement weather days increases, the duration of this allowance or activity will decrease the corresponding number of days. No other activities may be concurrent with this activity.
3. Delays in the construction due to inclement weather will be construed as excusable delay only for the days in which the inclement weather substantially caused delay in overall progress of the Project by affecting Critical Work Activities.
4. Contractor shall submit a written claim on Company letterhead for each delay due to inclement weather within two (2) calendar days from the day of inclement weather. Contractor shall document the date and the nature of the inclement weather, the specific activity in which the inclement weather caused delay, and the task or operation in each trade that was delayed and its relation to the Critical Path.
  - a. The OWNER's Representative will review the claim and the written documentation submitted by the Contractor and compare with the Contract Schedule. If the OWNER's Representative finds that the inclement weather did substantially cause delay in the overall progress of the Project, the delay will be deemed an excusable delay.
5. Excusable delays shall be first deducted from the allowance of excusable delays shown on the Contract Schedule. When the total number of days for excusable delays due to inclement weather exceeds the allowance, the excess will be granted through extension of the Contract Time by Change Order the affected bid Categories only in accordance with the provisions of the General Conditions. Extension to the Contract Time due to inclement weather will be granted only for excusable delay in excess of the allowance.
6. If the Contractor fails to submit a claim and documentation within the stipulated time, the inclement weather shall be construed to have caused no delay in the construction.
7. WEEKEND / AFTERHOURS WORK OR MODIFIED HOURS
  - a. It is each Contractor's responsibility to meet each completion date for each task on the schedule, which in turn, may or may not specifically identify required weekend, after hours work, or modified working hours. These provisions shall also apply, but not limited to utility tie-ins, system related tie-ins, switchovers, site need considerations, contractor delay, and etc. type of work.
  - b. When the facility operation will or may be impacted, contractor MUST have performed their respective work on the weekend, afterhours or during modified working hours to complete scheduled activities at NO additional expense to the Owner.
  - c. Extended work shifts and/or working on Saturdays will be required for specific trades to meet the construction schedule. Refer to the general conditions for additional information.

1.05 SUBMITTALS

- A. Contractor shall comply with Division 00 and 01 for the compliance and procedure of submittal submission.

- B. All submittals regardless of when the respective scope of work is scheduled to be installed shall be completely submitted within the time frames as established in the PROJECT CONSTRUCTION SCHEDULE.

1.06 COORDINATION DRAWINGS

- A. Refer to section 01 31 13 Utility Coordination for additional specific information.

1.07 PROCUREMENT / FABRICATION SCHEDULE

- A. The General Contractor shall provide dates as to when material must be ordered / fabricated and delivered to the project site. At no time shall delivery of material later than what is required as not to impact the schedule or dependent contractors will be acceptable.

- B. Contractor shall provide written confirmation of ordered / fabricated material and delivery.

1.08 DAILY WORK REPORTS

- A. Each trade shall provide a daily work report each day. Refer to section 01 99 99 – Forms for the form that will be used.

**PART 2 – PRODUCTS**

NOT USED

**PART 3 – EXECUTIONS**

NOT USED

END OF SECTION

## SECTION 01 31 13

### UTILITY COORDINATION

#### **PART 1 - GENERAL**

##### **1.01 PROJECT COORDINATION**

- A. Coordinate the interrelationship of major system assemblies their relationship with the Work.
- B. Coordinate the Work of Contractors so that portions of the Work are performed in a manner that minimizes interference with the progress of the Work.
- C. Do not obstruct spaces and installations that are required to be clear by Applicable Code Requirement.
- D. Do not cover any piping, wiring, ducts or other installations until they have been inspected and approved and required certificates of inspection issued.
- E. Remove and replace all Work which does not comply with the Contract Documents or applicable codes. Repair or replace any other Work or property damaged by these operations at no increase in Contract Sum.
- F. Components of construction, building lines, building floor elevations, and other details of the Work shall be accurately laid out within the tolerances specified for type of Work and materials indicated. Contractor shall require use of established lines and elevations for all Work.
- G. Contractor's Engineering: Certain portions of the Work may require engineering development or other engineering services by Contractor. Scope of services and other requirements shall be as indicated in technical specification sections.
  - 1. For portions of the Work specified for engineering development by Contractor's Professional Engineer, shop drawings, calculations, and other data shall be submitted bearing the California registration seal and self-written signature of the Contractor's Professional Engineer.
  - 2. Contractor's Professional Engineer shall review the material proposed by Contractor, related to the portions of Work requiring Contractor's engineering development, for conformance with the Contract Documents and for compliance with Contractor's Professional Engineer's own engineering design.

#### **PART 2 – COORDINATION AND DETAILING ACTIVITY (CDA)**

##### **2.01 DEFINITION**

- A. The Coordination Detailing Activity is an on-site coordination program to confirm aspects of the project's design in an orderly, systematic way. The Construction Manager, Contractor's Staff, Subcontractor's Staff are required to participate in this program. The basis of the Coordination Detailing Activity is to assure that all utilities, architectural, and structural building systems are inter-coordinated and agreed upon by Contractor, his Subcontractors and related Trade Contractors, before Work begins in the field. At the completion of the Coordination Detailing Activity, affected Contractors are required to sign off their acceptance indicating that the Work represented on the coordination drawing is constructible and has been reviewed by them and that they are in concurrence with information contained on the drawings.



## 2.02 DESCRIPTION

A. The Coordination Detailing Activity effort will be required on the following:

1. Coordination of water (domestic as well as fire), sewer, gas, and storm drain systems specified in Division 33.
2. Coordination of all site work specified in Division 2, 31, 32 and 33.
2. Coordination for all items of work specified by Division 21.
3. Coordination for all items of work specified by Division 22.
4. Coordination for all items of work specified by Division 23.
5. Coordination for all items of work specified by Division 26.
6. Coordination for all items of work specified by Division 27.
7. Coordination for all items of work specified by Division 28.
8. Utility coordination with architectural and structural work.
9. Underground utility coordination with existing underground utilities.
10. Coordination of all building elements for selected architectural elevations.

B. The provisions of this section do not lessen Contractor's responsibility for providing adequate coordination, including attendance at work site meetings as required by Construction Manager, for any and all work including work not indicated above.

## 2.03 CONTRACTOR COORDINATION RESPONSIBILITIES

A. Notwithstanding the information shown on the drawings and indicated in the specifications, Contractor fully recognizes that the drawings are only diagrammatic and are not intended to necessarily represent actual fit, tolerances, clearances, routing, or offsets required to achieve final coordination of systems or building components or to otherwise avoid conflicts between such components or systems. Contractor has adequately reviewed these documents to determine the degree of difficulty required on his part to achieve proper coordination and has allocated sufficient money and personnel (notwithstanding the minimum personnel requirements stipulated in the Contract) to accomplish the necessary coordination, fit and routing of systems or components. Construction Manager and the Architect are not responsible for the quality or content of Contractor's work.

## 2.04 ORIENTATION MEETING

- A. The purpose of the CDA is to expeditiously produce fully coordinated shop drawings showing a composite of systems, subsystems, along with architectural and structural elements of the work prior to fabrication of building systems.
- B. Prior to the start of the CDA, meet with Construction Manager, County's Project Manager and Architect to discuss the coordination effort. The purpose of this meeting is to develop a mutual understanding of the administration of the CDA and the scope of the required submittals and drawings. The Orientation Meeting must be attended by all affected Contractors as required in Section 2.02.

## 2.05 COORDINATION MEETINGS

A. During the CDA meetings with Construction Manager, the Architect and Contractors, discuss and coordinate the locations of utilities and building elements, problems of fit, trade interfaces, and constructability. As a minimum, coordination meetings will be held at the 30%, 90% and 100% points prior to the CDA finish. The purpose of the 100% completion meeting is for all Contractors to sign the fully coordinated drawings indicating their full approval and that each Subcontractor has fully coordinated his work with the work of all Contractors.

- B. Construction Manager and Architect will review and evaluate the routings and placements of the coordinated utilities for compliance with the original design intent only.
- C. Contractor may be required to attend additional coordination meetings as required at no additional expense to County. Contractor's subcontractors may be required to attend CDA meetings as necessary.

## 2.06 TYPICAL COORDINATION DETAILING ACTIVITY (CDA) SEQUENCE

- A. Prepare Structural Steel Shop Drawings: Contractor shall review the Contract Documents and prepare steel shop drawings in the sequence in which they are envisioned to be erected. Compare the shop drawings with the architectural drawings and mechanical, electrical and plumbing requirements with respect to structural openings through decks or utility requirements between structural members, and identify any conflicts. Prepare redline drawings depicting structural to architectural, mechanical, electrical conflict and plumbing systems and proposed solution to noted conflicts and submit to Construction Manager.
- B. Prepare Background Drawings: The Mechanical / Plumbing / Fire Protection Contractors shall agree upon a background drawing that will become the common background for the detailing of the work of all Contractors. The background shall accurately reflect wall lines and other elements of the project, such as beams, columns and existing utilities. In addition to the wall layout of the new work, the background drawing shall include the anticipated locations of all light fixtures, diffusers and access panels. Finish ceiling elevations and above ceiling structural mounts for equipment shall be accurately dimensioned and noted on the drawings.
- C. Approve Background Drawings: Upon completion, the background drawing will be reviewed by the Contractors. All Contractors will sign the background drawings, indicating their approval and agreement to use the drawing as common background for all coordination. When approved, the drawing shall be distributed to all Contractors by Construction Manager, to be used as the background for the preparation of the coordination drawings for each discipline.
  - 1. Detail duct and gravity flow lines: The Mechanical Contractor shall detail the mechanical duct work (being the largest above-ceiling utility) and gravity flow plumbing lines as the first elements to be depicted and coordinated on the approved background drawings.
  - 2. Identify conflicts with proposed building systems: The Mechanical Contractors shall identify any and all conflicts associated with the proposed routing of the mechanical ductwork and the gravity flow plumbing lines, whether the conflicts are with new or with existing underground utilities, structural members, or otherwise, within the space.
  - 3. Resolve conflicts and re-detail as required: The Mechanical Contractors shall prepare a conflict list identifying any conflicts and prepare a plan view and cross sectional drawings that accurately represent the nature and location of the conflicts in plan and elevation. Contractors shall work with Construction Manager and the architect to identify alternate acceptable routes for new work in conflict. The Mechanical Contractors shall re-detail coordination drawings as required to avoid building systems that cannot be relocated.
  - 4. Prepare overlay drawings for coordination of electrical and remaining mechanical systems on background drawings: Upon the completion of the HVAC and gravity flow coordination effort, the building systems provided by the electrical pneumatic tube, control systems, plumbing and fire sprinkler Contractors will be integrated with the HVAC and gravity flow lines by each respective Contractor. Contractors shall prepare an overlay coordination drawing for each system: electrical, plumbing, steam, chilled water, fire sprinklers etc. The approved background with mechanical ductwork and gravity flow plumbing system will serve as the background for these

systems.

5. Identify conflicts with and proposed systems: Contractors will compare and identify conflicts between their proposed systems and all other systems proposed or existing and revise their coordination drawing with the intent of eliminating or reducing the interferences and conflicts. Contractors shall work closely with Construction Manager, their Subcontractors, affected Contractors, and the Architect to integrate and coordinate all new systems within the design intent.
  6. Resolve conflicts and re-detail as required: Upon the completion of this coordination effort, Contractors shall develop a conflict list that shall identify all systems that, notwithstanding the previously described coordination effort stated herein, are in conflict with another building system. Contractors shall also prepare plan view and cross sectional drawings as required to accurately identify the conflict and its exact location. All Contractors shall re-detail coordination drawings as required to avoid building systems that cannot be relocated.
  7. Sign drawings indicating full coordination and fit of all new building systems: The end product of this effort will be a fully coordinated set of drawings, consistent with the design intent and applicable building codes, for the new work of the project. Upon the completion of the coordination drawings, Contractors will indicate they have coordinated their work by signing the coordination drawing. Upon completion of the Coordination Drawing, shop Drawings and fabrication can proceed.
- D. All conflicts will be resolved through the CDA process rather than at the installation stage. Conflicts occurring at the installation stage will not be the basis for additional costs or time extensions. Request for Information (RFIs) will not be accepted by the Construction Manager during the CDA process for any issue being currently coordinated. Issues shall be resolved via the CDA process and documented on the coordination drawings.
  - E. Coordination effort will include review of all construction documents for their completeness, constructability and code compliance. Failure to perform this satisfactorily will not be the basis for additional compensation after signing the coordination drawings.
  - F. All conflicts will be resolved through the CDA process rather than at the installation stage. Conflicts occurring at the installation stage will not be the basis for additional costs or time extensions. Issues shall be resolved via the CDA process and documented on the coordination drawings.
  - G. Coordination effort will include review of all construction documents for their completeness, constructability and code compliance. Failure to perform this satisfactorily will not be the basis for additional compensation after signing the coordination drawings.

## 2.07 COORDINATION SCHEDULE

- A. The entire CDA process must take place in such a time as not to impact shop drawing preparation, material procurement, and the Project Schedule. Refer to Section 01 32 16 for deliverables time lines and associated liquidated damages.

**END OF SECTION**

## SECTION 01 31 19

### PROJECT MEETINGS

#### PART 1 – GENERAL

##### 1.01 REQUIREMENTS INCLUDED

- A. The County's Representative will schedule and administer a pre-construction meeting, regular progress meetings, and specifically called meetings throughout progress for the work and will:
1. Prepare agenda for meetings.
  2. Make physical arrangements for meetings.
  3. Preside at meetings.
  4. Record the minutes; include significant proceedings and decisions.
  5. Reproduce and distribute copies of minutes after each meeting to participants in the meeting and to parties affected by decisions made at the meeting.

Contractor representatives, subcontractors and suppliers attending meeting shall be qualified and authorized to act on behalf of entity each one represents.

##### 1.02 PRE-CONSTRUCTION MEETING

- A. Timing: Prior to start of construction.
- B. Attendance: Architect and consultants as appropriate, County's Representative, Construction Manager, Trade Contractors (including subcontractors, manufacturers and suppliers) as requested, and Inspector.
- C. Purpose: To discuss and familiarize contractors with project procedures, expectations and deliverables, schedule, safety procedures, labor compliance

##### 1.03 COORDINATION MEETINGS

- A. Timing: Once per week, at a minimum, day and time to be determined by Construction Manager.
- B. Attendance: Construction Manager and Trade Contractors and their subcontractors as necessary. Architect, consultants, and inspector as required. Contractors shall begin attending the meeting at least three (3) weeks prior to mobilizing their crews. **Attendance is not optional, it is mandatory.**
- C. Purpose:
1. To provide a formal and regular forum for the Construction Manager and Contractors to present: questions, problems or issues that need to be addressed safety concerns, review the progress on previous issues and action items, submittal and schedule review. All necessary coordination with dependent Trades.
  2. To review the 4 week look ahead schedule produced by the Construction Manager, reviewed by the foremen's with collaborative feedback, agreement to execute.
  3. This shall **not** be the only or sole time that the items noted above shall be presented or addressed. Each Trade Contractor has a responsibility to address such items in a timely manner as not to impact dependent trades or the project schedule.

1.04 SPECIAL CALLED MEETINGS

The County's Representative may call a special meeting at any time during the course of the project. Special project meetings shall include representatives of any members of the project team requested in order to discuss problems and/or solutions that are common to the project.

**PART 2 – PRODUCTS**

NOT USED

**PART 3 – EXECUTION**

NOT USED

END OF SECTION

NOT FOR BID

## SECTION 01 33 00

### SUBMITTAL PROCEDURES

#### **PART 1 – GENERAL**

##### 1.01 SECTION INCLUDES

- A. Procedural requirements for non-administrative submittals including product data, shop drawings, samples and other miscellaneous work-related submittals required by Contract Documents.
- B. Refer to Division 00 and other Division 01 sections and other contract documents for specifications for administrative submittals; such submittals include, but are not limited to following items:
  - 1. Permits.
  - 2. Payment applications.
  - 3. Performance and payment bonds.
  - 4. Insurance certificates.
  - 5. Inspection and test reports.
  - 6. Schedule of values.
  - 7. Progress schedule.
  - 8. Listing or designation of subcontractors.
  - 9. Record drawings
- C. Designate in progress schedule, or in separate coordinated schedule, dates for submission and dates reviewed shop drawings, product data and samples will be needed for each product.
  - 1. Identify items requiring long lead times.
- D. The Contractor's submittal and Architect's acceptance of Product Data, Shop Drawings or Samples that relate to construction activities not complying with Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval.
- E. Product Data, Shop Drawing and Sample Submittals containing substitutions for specified items will be rejected and returned as not in compliance with Contract Documents.

##### 1.02 PRODUCT DATA

- A. Product Data includes standard printed information on manufactured products that has not been specially prepared for this Project, including but not limited to following items:
  - 1. Manufacturer's product specifications and installation instructions.
  - 2. Standard color charts.
  - 3. Catalog cuts.
  - 4. Roughing-in Diagram and templates.
  - 5. Standard wiring diagrams.
  - 6. Printed performance curves.
  - 7. Operational range diagrams.
  - 8. Mill reports.

9. Standard product operating and maintenance manuals.
- B. Modify standard drawings to delete information which is not applicable to the Project.
- C. Supplement standard information to provide additional information specifically applicable to Project.
  1. Clearly mark each copy to identify pertinent materials, products or models.
  2. Show dimensions and clearances required.
  3. Show performance characteristics and capacities.
  4. Show wiring or piping diagrams and controls.

#### 1.03 SHOP DRAWINGS

- A. Shop drawings are technical drawings and data that have been specially prepared for Project, including but not limited to following items:
  1. Fabrication and installation drawings.
  2. Setting diagrams.
  3. Templates.
  4. Patterns.
  5. Coordination drawings (for use on-site).
  6. Schedules.
  7. Design mix formulas.
  8. Contractor's engineering calculations.
- B. Standard information prepared without specific reference to Project is not considered to be shop drawings.

#### 1.04 SAMPLES

- A. Samples are physical examples of Work, including but not limited to following items:
  1. Partial sections of manufactured or fabricated work.
  2. Small cuts or containers of materials.
  3. Complete units of repetitively used materials.
  4. Swatches showing color, texture and pattern.
  5. Color range sets.
  6. Units of work to be used for independent inspection and testing.
- B. Office Samples:
  1. Provide in specified size and quantity to clearly illustrate:
    - a. Functional characteristics of product or material, with integrally related parts and attachment devices.
    - b. Full range of color, texture, and pattern.
  2. Where size and quantity is not specified, provide minimum of four samples, 12 inch by 12 inch minimum size, where samples are required.
- C. Field Samples and Mock-Ups:
  1. Erect at Project Site in location acceptable to Architect.
  2. Construct each sample or mock-up complete, including work of trades required in

finished work.

3. Size or area as specified in respective specification section.
4. Remove mock-ups at conclusion of Work or when acceptable to Architect and dispose legally.

1.05 VERIFIED REPORTS

- A. Submit Verified Reports shall be submitted when required by the County, the Inspector of Record, the Architect and/or their Consultants, or as required by regulatory agencies, codes, laws, ordinances, etc.

1.06 DEFERRED APPROVALS

- A. Submit detailed plans, specifications and engineering calculations for Deferred Approval items.
- B. Calculations and drawings of structural nature shall be prepared and signed by registered Structural Engineer licensed in State of California.
- C. Submit 8 sets.
  1. If revisions are necessary, Architect will return one (1) set to contractor.
  2. Resubmit 8 sets with corrections.
- D. Fabrication and installation of Deferred Approval items shall not be started until detailed plans, specifications and engineering calculations have been accepted by Architect, Design Consultants, Building Officials, Regulatory Agencies, and/or County.

1.07 MISCELLANEOUS SUBMITTALS WORK-RELATED

- A. Include, but not limited to following types of submittals:
  1. Specially-prepared warranties (guarantees).
  2. Standard printed warranties.
  3. Maintenance agreements.
  4. Printed industry standards.
  5. Collected and bound operating/maintenance manuals.
  6. Keying schedule, keys and other security protection safety devices.
  7. Maintenance tools and spare parts.
  8. Maintenance materials and overrun stock.

1.08 CONTRACTOR RESPONSIBILITIES

- A. As defined in General Conditions.
- B. Review shop drawings, product data and samples for compliance with Contract Documents prior to submission.
- C. Determine and Verify:
  1. Field measurements.
  2. Field construction criteria.
  3. Catalog numbers and similar data.
  4. Conformance with Specifications and Drawings.
- D. Coordinate each submittal with requirements of Work and of Contract documents.
- E. Notify Architect in writing, at time of submission, of deviations in submittals from requirements of Contract Documents.



- F. Do not begin fabrication or work which requires submittals until return of submittals with Architect's approval.

#### 1.09 SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in Work or in work of other contractor.
- B. Coordinate transmittal of different types of submittals for related elements of Work so processing will not be delayed by need to review submittals concurrently for coordination.
  - 1. The Architect reserves right to withhold action on submittal requiring coordination with other submittals until related submittals are received.
- C. Accompany submittals with an accurately completed transmittal form provided in section 01 99 99 - Forms.
  - 1. Submittals not accompanied by such form, or where applicable items on form are not completed, will be returned for resubmittal.
    - a. Sample of transmittal form is included at end of this section.
  - 2. Photo copy related specification section identifying submittal requirements and identify/bubble items that are being submitted.
- D. Use a separate transmittal form for each specific item or class of material or equipment for which submittal is required.
  - 1. Transmittal of submittals on various items using single transmittal form will be permitted only when items taken together constitute manufacturer's package or are so functionally related that expediency indicates review of group or package as whole.
- E. Schedule submissions per the deliverable timelines as specified in section 01 32 16.
  - 1. No extension of Contract Time will be authorized because of failure to transmit submittals to Architect sufficiently in advance of Work to permit processing.
- F. Number of Submittals Required: Submit quantities as follows.
  - 1. Shop Drawings: Submit eight (8) full-sized/legible copies.
  - 2. Product Data: Submit eight (8) copies of manufacturer's product data.
  - 3. Samples: Submit number stated in each specification section, or, if not stated, submit as specified.
  - 4. Warranties, Maintenance Agreements, Industry Standards, and Operating/Maintenance Manuals: Submit four (4) copies.
  - 5. Electronic Copies: Where deemed necessary or applicable to the project, electronic copies may allowed to be provided in lieu of hard copies. Prior written approval must be granted before electronic copies shall be deemed acceptable. This clause does not apply to samples and/or mock-ups.
- G. Accompany submittals with transmittal form provided by Architect, containing:
  - 1. Date.
  - 2. Project title and number.
  - 3. Contractor's name and address.
  - 4. Number of each shop drawing, product data and sample submitted.
  - 5. Notification of deviations from Contract Documents.
  - 6. Pertinent data.

H. Submittals shall include:

1. Date and revision dates.
2. Project title and number.
3. Names of:
  - a. Architect/Engineer.
  - b. Contractor.
  - c. Subcontractor.
  - d. Supplier.
  - e. Manufacturer.
  - f. Separate detailer when pertinent.
4. Identification of product or material.
5. Relation to adjacent structure or materials.
6. Field dimensions, clearly identified as such.
7. Specification section number.
8. Applicable standards, such as ASTM number or Federal Specification.
9. A blank space, 8 inch by 3 inch, for Contractor and Architect stamps.
10. Identification of deviations from Contract Documents.
11. On each sheet, provide contractor's stamp, initialed or signed, certifying to review of submittal, verification of field measurements and compliance with Contract Documents.
12. Submittals without Contractor's review stamp on each sheet will be returned, without action, for resubmittal.

1.10 RESUBMISSION REQUIREMENTS

A. Shop Drawings:

1. Revise initial drawings as required and resubmit as specified for initial submittal.
2. Indicate on drawings any changes which have been made or than those requested by Architect.

B. Product Data and Samples: Submit new data and samples as required for initial submittal.

1.11 DISTRIBUTION OF SUBMITTALS AFTER REVIEW

A. Construction Manager to distribute Shop Drawings and copies of Product Data and approved Deferred Approvals (if any), which carry Architect/Engineer stamp, with such reasonable promptness as to cause no delay in Work, but no later than three working days of receipt, to:

1. Job site file.
2. Record Documents file.
3. Prime Contractor.
4. Affected contractors.
5. Owner's Inspector.

B. Prime Contractor is responsible to coordinate distribution to their subcontractors and internal staff.

C. Distribute samples which carry Architect's review stamp as directed by Architect.

#### 1.12 ARCHITECT'S DUTIES

A. As defined in the General Conditions.

B. Architect will review submittals as originally submitted, as well as first resubmittal, at Architect's own cost.

1. Architect's cost for reviewing additional resubmittals made or required, will be paid by Owner with reimbursement from Contractor by deductive change order.

C. Action Stamp: Architect will stamp each submittal with uniform, self-explanatory stamp will be appropriately marked, as follows, to indicate action taken:

1. Final Unrestricted Release: Where submittals are marked "**No Exception Taken**", that part of Work covered by submittal may proceed provided it complies with requirements of Contract Documents; final acceptance will depend upon that compliance.
2. Final-But-Restricted Release: When submittals are marked "**Make Corrections Noted**", that part of Work covered by submittal may proceed provided it complies with notations or corrections on submittal and requirements of Contract Documents; final acceptance will depend on that compliance.
3. Returned for Resubmittal: When submittal is marked "**Rejected**" or "**Revise and Resubmit**", do not proceed with that part of Work covered by submittal, including purchasing, fabrication, delivery, or activity.
  - a. Revise or prepare new submittal in accordance with notations; resubmit without delay.
    - 1) Repeat if necessary to obtain different action mark.
4. Do not permit submittals marked "Rejected" or "Revise and Resubmit" to be used at Project Site, or elsewhere where Work is in progress.

D. Unsolicited Submittals: Architect will return unsolicited submittals to sender without action.

### **PART 2 – PRODUCTS**

NOT USED

### **PART 3 – EXECUTION**

#### 3.01 SUBMITTAL FORM

A. Refer to Section 01 99 99 for required form.

**END OF SECTION**

## SECTION 01 44 40

### SITE SAFETY PROGRAM

#### PART 1 – GENERAL

##### 1.01 SECTION INCLUDES

Summary of safety requirements and procedures that are to be followed in addition to the Contractor's Injury and Illness Prevention Program (IIPP). The following items are intended as minimum requirements for Contractors compliance with safety, health, and environmental laws and regulations of safe work practices. This section is **NOT** intended as a complete safety program. Safety shall be in accordance with State and Local Agencies.

##### 1.02 DEFINITIONS

- A. Incident – An unexpected happening causing loss or injury, including, without limitation, accidental or unanticipated events involving the potential for personal injury, illness or property damage.
- B. Job Hazard Analysis (JHA) – A task-driven planning document used to help ensure every task receives proper safety assessment and planning.
- C. Competent Person – One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, is knowledgeable of applicable regulations and who has authorization to take prompt corrective measures to eliminate them.

##### 1.03 GENERAL REQUIREMENTS

- A. The requirements set forth in this Section are complementary to, and do not supersede, the requirements of the General Conditions or other provisions of the Contract Documents pertaining to safety. In the event of a conflict between or among provisions relating to safety or protection, the provision that requires the greater degree and higher level of action, care, caution or protection shall govern.
- B. Contractor shall comply fully with all Federal, State and/or Local safety related laws, orders, citations, rules, regulations, standards and statutes.
- C. The Contractor has sole responsibility, on a twenty-four (24) hour day, seven (7) day week basis, for initiating, maintain and supervising all safety precautions and programs in connection with the performance of the work. No actions, inspection or approvals by the Owner, or other acting on behalf of the Owner shall diminish such Contractor responsibility.
- D. Contractor shall be responsible for any additional tier Contractors (second and lower tier Contractors) under the first tier Contractor's control. Sub-tier contractors are expected to comply with these minimum safety standards, and Federal, State and/or Local safety related laws orders, citations, rules, regulations, standards and statutes.
- E. Contractor shall have sole responsibility for providing a safe workplace in performing its work and for its employees and its Sub-tier Contractors employees.
- F. Contractor shall make Construction Manager immediately aware of any unique safety, health, or environmental concerns related to their work and make timely efforts to notify other affected contractors working on site and protect the public from hazards.
- G. If Contractor or Sub-tier contractor employs non-English speaking tradespeople, the Contractor and/or Sub-tier contractor shall have supervisory personnel (Superintendent or foreman) proficient in English and the foreign language(s) relative to these tradespeople.

- H. A site-specific "Project Safety Plan" shall be prepared by the Contractor and submitted to Construction Manager for its review prior to mobilizing at the site. The Project Safety Plan must include, at a minimum and without limitation (but not limited to):
  - a. The work to be performed at this project location (Scope of work) and how that work will be done safely taking into consideration the workers, inspectors, visitors, and the general public (e.g. students, faculty, pedestrians, etc.).
  - b. Indoctrination course process before any person starts on the project
  - c. How will this be submitted to Construction Manager
  - d. Project-specific "Emergency Response Action Plan" in accordance with applicable laws and contract requirements.
- I. Contractor shall inform Construction Manager immediately of any safety or health inspections or other actions by Cal/OSHA, EPA, AQMD, Water Control Board, Health Department, or other Governmental Authorities.
- J. Contractor is responsible for maintaining all postings required by Applicable Laws and the Contract Documents, such as, but not limited to, the Cal/OSHA poster, Cal/OSHA 300 & 301 logs, First Aid Register, accident reports, equipment inspection records, and health and safety training records for workers.
- K. Contractor shall provide First Aid Kit/supplies in accordance with Cal/OSHA for their employees and comply with governing regulations.
- L. Contractor shall provide Fire Extinguishers of the appropriate size and type to be used and in accordance with NFPA recommendations for the type of exposure.

#### 1.04 PRE-CONSTRUCTION

- A. Prior to receiving the first payment, Contractor shall:
  - a. Submit to Construction Manager a copy of its Project specific Injury and Illness Prevention Plan (IIPP).
  - b. Submit to Construction Manager a copy of its Project specific Material Data Safety Sheets (MSDS).
  - c. Submit to Construction Manager a copy of its Heat Illness Prevention Plan (HIPP).
  - d. Submit to Construction Manager, and update as required, Contractor's Hazard Communication Program, Safety Data Sheets (SDS), and chemical inventory list for the project.
  - e. Submit a list of all First Aid/CPR trained employees on the project, expiration dates, and update when requested by Construction Manager.
  - f. Submit to Construction Manager a list identifying their "Competent Person" for the following activities (as they apply) such as, but not limited to the following, along with documented training:
    - i. Demolition
    - ii. Lead Abatement
    - iii. Asbestos Abatement
    - iv. Ladder Inspection
    - v. Trench/Excavation and Shoring
    - vi. Scaffold Erection and Inspection
    - vii. Fall Protection

viii. Steel Erection

- g. Submit to Construction Manager a list of their **Forklift Operators** that will be on the project, copies of their certification, expiration date, and update when new operators arrive on site.
- B. A Competent Person shall be readily available on-site during any of the referenced activities above, or activity identified by Construction Manager and/or Owner.

1.05 PROJECT SAFETY ORIENTATION AND TRAINING

- A. All Contractor and Subcontractor's employees are required to complete a site-specific health and safety orientation provided/facilitated by the respective trade contractor before each new personnel starts.
- B. Each indoctrination form (provided by trade contractor) shall be submitted to Construction Manager before the new personnel starts. Should Construction Manager not receive the form, the new personnel shall be removed from the site until such orientation and indoctrination form has been provided. Any impact this may have on the timely performance of the respective activity or dependent trades, shall be at the expense of this trade contractor.
- C. Contractor is responsible for all safety, health and environmental training related to their work.
- D. Contractor shall certify that each operator of mobile equipment such as forklifts, cranes, boom lifts, etc., has been trained and/or certified on the proper operation of the equipment. Copies of proof of training or certification shall be submitted to Construction Manager.
  - a. Proof of training or certification of mobile crane operators must be provided for each specific crane (type and rating) they are assigned to operate.
- E. Contractor must establish a prompt and effective method of providing health and safety communications such as safety alerts, bulletins, regulatory updates, etc. to all employees of Contractor and Subcontractors on the Site.

1.06 INJURY AND ACCIDENT REPORTING

- A. Contractors are required to notify Construction Manager's Project Superintendent immediately of any incident/accident. This includes any member of the general public, third party, and/or property damage.
- B. A detailed written accident report is to be furnished to Construction Manager within **twenty-four (24) hours of the incident/accident**.
- C. Additional information such as, but not limited to the following, shall be provided to Construction Manager once available; copies of all reports of any injury to their employees and/or accidents/incidents involving other people (e.g. general public) or property damage caused by their actions.
- D. Signed statements shall be from witnesses of their observations. Witness statements shall contain the name and permanent address of the witness.
- E. Recommendations to prevent recurrence of the incident shall be documented, communicated to all employees of the Contractor (e.g. tailgate meeting), and signed copies shall be submitted to Construction Manager on the same day they are conducted.
- F. Contractors are required to notify Construction Managers Project Superintendent the same day of any "near-miss" incidents.
- G. A written report of the "near-miss" incident is to be furnished to Construction Manager within **twenty-four (24) hours**.

#### 1.07 SAFETY MEETINGS

- A. Contractor shall conduct weekly safety meetings for their crew(s) and sub-tier contractors in compliance with Cal/OSHA standards, which address the specific hazards associated with their trade, signed by attendees, and shall provide a copy of the meeting minutes to Construction Manager weekly.
- B. Contractor's Superintendent and/or Foreman shall be present at all Construction Manager scheduled safety/coordination meetings.
- C. Contractor personnel will attend any meeting, such as an "all hands safety meeting", scheduled by the Construction Manager related to safety.

#### 1.08 SAFETY INSPECTIONS

- A. Contractor shall designate an on-site safety representative (e.g. Superintendent, Foreman), who shall conduct and document a weekly safety inspection of their work areas, and submit a copy to Construction Manager on the same day the inspection was performed.
- B. Any and all conditions that may affect the safety of persons or property will be noted in writing for immediate correction.

#### 1.09 DISCIPLINARY POLICY AND ENFORCEMENT

- A. A plan for disciplinary action for violations of known safety requirements shall be part of the Contractor's IIPP.
- B. The program is the minimum safety standards established for this project, and is not intended to take the place of a Contractor's Disciplinary Policy.
- C. The Construction Manager reserves the right to stop Contractor's work if the Construction Manager believes the Contractor is not performing their work in compliance with any applicable safety laws or regulations or agreed upon safety action plan/program (e.g. JHA, Crane pick plan). The work activity will cease until corrective action is taken by the Contractor.
- D. If Contractor fails to take corrective action, the Construction Manager, in its discretion, shall have the right, but not the obligation, to take corrective action and to charge the cost and/or expense thereof against Contractor.
- E. Safety Hazard Notifications will be sent to Contractor observed violating safety regulations. Failure to correct the unsafe condition(s) noted on the Safety Hazard Notification is in violation of their contract, and may result in payments being withheld until the conditions noted are corrected.
- F. The Contractor agrees to enforce compliance with the following disciplinary actions as a result of committing a safety violation:
  - a. **Action Level One (1)** – If Construction Manager observes that Contractor has failed to comply with any safety requirements applicable to the work, the Construction Manager will have the right, but not the obligation, to issue a written "Notice of Safety Non-Compliance" to the Contractor. The Construction Manager will have the further right, but not the obligation, to forward a "Warning Letter for Safety Non-Compliance" and a copy of the Notice of Safety Non-Compliance to the Contractor's reputed Executive in charge, such as its President or Operations Manager, and Contractor's Sureties.
  - b. **Action Level Two (2)** – If an observed non-compliance with safety requirements is not corrected by Action Level One, or if the Contractor repeatedly fails to comply with the safety requirements applicable to the Project, the Construction Manager shall have the right, but not the obligation, to issue a "Written Notice of Temporary Job Suspension" to the Contractor and its Sureties. The Contractor may not resume Work until the Construction Manager and the Contractor's reputed Executive in

charge, such as its President or Operations Manager, have met and the Contractor has demonstrated that it is prepared and able to take specific and adequate corrective actions. Actions that the Construction Manager may, in the exercise of its sole discretion, require of Contractor include, but are not limited to, the following:

- i. Removal of certain Contractor or Subcontractor personnel from the site
  - ii. Alteration of the Contractor's or Subcontractor's job procedures
  - iii. The Contractor shall not resume work until proposed corrective actions are reviewed by the Construction Manager and the Construction Manager has agreed to the work proceeding. The Construction Manager will document the meeting results in the form of meeting minutes, a copy of which will be provided to the Contractor and maintained at the site.
- c. **Action Level Three (3)** – If Action Levels One and Two do not result in the Contractor's performance being brought into compliance with applicable safety requirements, then other actions, including, without limitation, contract termination may result. A Contractor whose contract is terminated in accordance with this procedure will be ineligible to bid or participate in future projects.
- d. Nothing stated above or in this section shall be interpreted as creating or implying any obligation on the part of the Owner or Construction Managers to issue any notices, whether formal or informal, to Contractor in the event of an incident or of circumstances involving the risk of an incident. Notices issued to Contractor, whether or not in the forms suggested above, shall be complied with by Contractor. Nothing stated above shall be interpreted as limiting any right's or remedies to the exercise of procedures set forth above or in this section.
- e. **IMMINENT DANGER** (any conditions or practices in any place of employment which are such that a danger exists which could reasonably be expected to cause death or serious physical harm) – Any imminent danger type safety violations shall result in **immediate suspension** and/or permanent removal from all Construction Manager Project(s).

#### 1.10 BARRICADES, SIGNS AND PERIMETER PROTECTION

- A. Contractor shall notify Construction Manager for approval to remove any barricades (e.g. guardrails), and other perimeter protection (e.g. fencing) and/or floor opening covers.
- B. Contractor shall ensure that all their jobsite personnel understand that removal of any barricades and other perimeter protection and/or floor opening covers must have prior approval from Construction Manager.
- C. Contractor shall notify all trades affected by the removal of any barricade, perimeter protection and/or floor opening cover, and will be solely responsible for area and worker safety during the period of temporary removal.
- D. Contractor shall return to proper condition and maintenance, any barricade, perimeter protection and/or floor opening cover removed because of their work.
- E. Contractor shall be responsible for placing appropriate signs (e.g. Powder Actuated Tool in Use) to warn employees and other trades.

#### 1.11 CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

- A. Without limitations to any other requirements of Applicable Laws or the Contract Documents, Contractor and Subcontractor is responsible for providing all Personal Protective Equipment (PPE) for their employees (e.g. hard hats, safety glasses, face shield, harness, lanyard, N-95 particulate mask, respirator, high visibility vest, hearing protection, etc.).
- B. Contractor is responsible for adequate training for the use of PPE that their employees will wear and/or use as required by applicable Cal/OSHA standards.



- C. Contractors employees, which include field personnel, management, vendors, lower tier-sub, and visitors must comply with the minimum PPE requirements of the project:
- D. Hard hats (ANSI Z89.1 or equivalent) shall be worn at all times while on the construction project site, except in the break areas and construction offices.
- E. Welders must wear a hard hat when using welding hoods.
- F. No metal hard hats, "cowboy" style hard hats, or bump caps allowed.
- G. Safety glasses (ANSI Z87.1 or equivalent) that meet Cal/OSHA standards for the exposure shall be worn at all times while on the construction project site, except in the break areas and construction offices.
- H. This includes employees with prescription eye wear.
- I. High visibility vests (Class 2 vest minimum) or shirts; safety green or yellow, shall be worn at all times and must be the outermost garment while on the construction project site, except in the break areas and construction offices.
- J. ANSI 107-2010 Class 3 vests are required for workers with high task loads in a wide range of weather conditions and where traffic exceeds 50 mph. These work activities could include but not limited to all roadway construction personnel, vehicle operators, utility workers, survey crews, emergency responders, and railway.
- K. Construction work boots (ANSI Z41.1 or equivalent) shall be worn at all times during the course of all construction activities. They must be substantial leather boots with good rubber soles.
- L. Additional foot protection (i.e. metatarsal guards, steel toe) may be required if there is a danger of foot injury due to falling objects, rolling objects, etc.
- M. Loafers, sandals, tennis shoes, running shoes, or open-toed shoes are not proper work shoes for the construction site and are not permitted.
- N. Long Pants are required at all times. No sweat pants.
- O. Shirts must have a minimum four (4) inch sleeve length over shoulders and shall be worn at all times.
- P. Tank tops, cut-offs, net shirts, sleeveless shirts are prohibited on the Projects.

#### 1.12 CRANES AND RIGGING

- A. Contractor shall create a written "Lift Plan" for all crane picks regardless of the capacity, and must be submitted to Construction Manager at least 72 hours prior to the work activity for review. The following documents must also be included in the "Lift Plan":
  - a. Copies of the Crane Certifications (annual and quadrennial)
  - b. Copy of the Crane Operators Certification
  - c. The name and supporting documents for qualified riggers and signal persons, which will be provided by the Contractor.
  - d. Lifts that exceed 75% (Critical Lift) of the rated capacity of the crane or derrick, or requires the use of more than once crane or derrick, requires:
  - e. Contractor's Senior Management written approval (submit to Construction Manager)

#### 1.13 FALL PROTECTION AND PREVENTION

- A. Contractor shall enforce a 100% fall protection policy for any work done above 6 feet; exceptions are for specific trades (connectors, roofers, etc.) that shall comply with Cal/OSHA standards. Fall protection must be used anytime employees are working (whether moving or stationary) in an unprotected elevation per Cal/OSHA standards, and anytime workers are in

an area where there could occur a fall from a surface that is not protected by handrails, hole-covers, guardrails or other approved fall elimination device.

- B. Contractors shall submit to Construction Manager a Written Fall Protection Plan if implementing a Controlled Access Zone (CAZ) or Controlled Decking Zone (CDZ) at least 72 hours prior to the work activity for review. Written Fall Protection plan must comply with Cal/OSHA standards.
- C. Contractors shall submit to Construction Manager documentation of training on Personal Fall Arrest System (e.g. harness, lanyard, anchor point) if any employee will be utilizing a body harness.

#### 1.14 FLOOR OPENINGS

- A. Contractor shall be responsible for covering floor openings it has created by complying with Cal/OSHA standards for protecting floor openings.

#### 1.15 HAZARDOUS MATERIALS AND TOXIC SUBSTANCES

- A. Contractor is responsible for the generation, management, and proper disposal of any hazardous material, toxic substances, or any related materials or substances, as defined or included in the definition of "hazardous material" under any applicable Federal, State, or Local Law, Regulation or Ordinance.
- B. Contractor agrees to submit a written request to Construction Manager Superintendent at least 72 hours prior to arrival of any large quantities (more than 55 gallons) of gasoline, diesel fuels and any solvent onto the site. Construction Manager Superintendent may or may not grant approval at his/her sole discretion.
- C. Contractor agrees to not bring hazardous wastes on site or generate hazardous waste without notifying Construction Manager at least 72 hours in advance for authorization.
- D. Contractor using any hazardous material or toxic substance shall notify all other contractors employees on the Project of their use, and what measures should be taken to prevent exposure.
- E. No chemical or material creating noxious or toxic fumes shall be used on the site without notifying Construction Manager Superintendent at least 72 hours in advance for authorization, which approval may be granted or withheld in the sole discretion of Construction Manager Superintendent.
- F. All incidents involving exposures to or releases of potentially hazardous substances must be reported immediately, verbally, and followed in writing within 24 hours to Construction Manager Superintendent.

#### 1.16 HOUSEKEEPING

- A. Contractor shall perform their work so as to maintain the Project site in a clean, safe and orderly condition.
- B. Contractor is responsible for clean-up and removal of their debris, excess material, trash, waste, tools, etc., on a daily basis. All work areas shall be kept clean at all times. If Contractor fails to perform this function, Construction Manager reserves the right to charge the Contractor for clean-up performed on their behalf by others.

#### 1.17 JOB HAZARD ANALYSIS (JHA)

- A. The Contractor and/or its lower tier Contractors shall develop and complete a Job Hazard Analysis (JHA) for critical activities identified by Contractor, lower tier Contractor, Construction Manager, and/or Owner.
- B. The JHA's are to be completed by a supervisor familiar with the work activity to be performed.

- C. The JHA will break down the work activity into key steps, identify the hazards associated with each step, and the controls to either eliminate, avoid and/or protect against potential accident.
- D. The supervisor will review the completed JHA with the crew performing the work activity.
- E. The completed JHA will be kept by the Contractor for future reference and a copy of the Completed JHA will be submitted to Construction Manager.

#### 1.18 RESPIRATORY PROTECTION

- A. Contractor employing persons who will be using respirators shall prepare and abide by a written Respiratory Protection Program for protection of employees who will be wearing a respirator.
- B. A copy of the Respiratory Protection Program shall be submitted to Construction Manager at least 72 hours prior to the commencement of work. The program shall comply with Cal/OSHA regulations and must include at least the following:
  - C. Proper respiratory selection
  - D. Proper respiratory training, and the required fit test procedures
  - E. Proper respirator cleaning, sanitation, inspection and maintenance
  - F. Respirator users medical clearance.

#### 1.19 SCAFFOLD

- A. Contractor shall inspect their scaffold prior to use each day by their designated Competent Person.
- B. Contractor shall have written document of their inspection and submitted to Construction Manager upon completion of the inspection.
- C. Contractor shall also have at each access point (e.g. ladder, stair tower), a "green" inspection tag. This tag shall also be signed by the Scaffold Competent Person daily prior to use as verification of their inspection.
- D. Untagged scaffolds shall not be used.

#### 1.20 STORM WATER POLLUTION PREVENTION PROGRAM (SWPPP)

- A. Contractor shall train their employees on the Best Management Practices (BMP's) to prevent erosion and silt infiltration into storm drains and tributaries.
- B. Contractor shall be responsible for any damages to the existing erosion control in place.
- C. Contractor shall abide by the Project SWPPP established by bid documents.
- D. Refer to Specification section 01 57 13

#### 1.21 TEMPORARY POWER (ELECTRICAL) AND LIGHTING

- A. Contractor shall ensure that all temporary power cords are heavy-duty construction grade, and are in good condition, and correct voltage and amperage rating.
- B. Contractor shall utilize Ground Fault Circuit Interrupters (GFCI) to protect all temporary electrical wiring and cord sets.
- C. Assured grounding (quarterly inspections) may be used in conjunction with GFCI protection, but is not permitted as an alternative to GFCI protection.
- D. Contractor is responsible for providing work task lighting for its employees and lower tier Contractors.

#### 1.22 TOOLS AND EQUIPMENT

- A. All tools and equipment on the construction site shall be used in accordance with the safety requirements of applicable laws, as well as manufacturer's instructions and guidelines. Tools and equipment shall not be altered in any way to adapt it for a use or task for which the manufacturer does not intend it without specific written approval by the manufacturer of the tools and/or equipment approving of such adaptations or alterations under the specific circumstances of such use or task. All written approvals by the manufacturer must be submitted to Construction Manager at least 72 hours prior to the work activity for review. All tools and equipment shall not be left unattended, and shall be locked and secured when not in use.

#### 1.23 TRAFFIC CONTROL

- A. Contractor is required to provide all traffic control provisions including but not limited to permit costs, flaggers, trench plates, barricades, and other temporary measures as determined necessary by local governing agencies (e.g. Cal/MUTCD) and Construction Manager to accommodate continued, safe vehicular and pedestrian traffic at all times when it is impacted by their work. This includes impacts caused by any work, deliveries, or other activities in and around the construction site, or in the public right-of-way.
- B. Contractor may be required to submit an approved Traffic Control Plan (TCP) to Construction Manager 72 hours prior to the work activity for review.

#### 1.24 TRENCH AND EXCAVATION

- A. Contractor shall inspect their trench and/or excavation prior to use each day by their designated Competent Person, regardless of the depth.
- B. Contractor shall have written document of their inspection and submitted to Construction Manager upon completion of the inspection.
- C. Contractor shall provide appropriate barricades to protect people from falling into the trench/excavation.

### **PART 2 – PRODUCTS**

NOT USED

### **PART 3 – EXECUTION**

NOT USED

**END OF SECTION**

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## SECTION 01 45 29

### TESTING LABORATORY SERVICES

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

###### A. Work Included:

1. Cooperate with the Owner's selected testing agency and all others responsible for testing and inspecting the Work.
2. The Contractor shall provide other testing and inspecting as in this Section and/or elsewhere in the Contract Documents.

###### B. Related Work:

1. Requirements for testing may be described in other Sections of the Project Manual.
2. Where no testing requirements are described, but the Owner decides that testing is required, the Owner may require the testing to be performed under current pertinent standards. Payment for testing will be made as described in this Section.

###### C. Work Not Included:

1. Selection of testing laboratory: The Owner will select a pre-qualified independent testing laboratory.
2. Payment for initial testing: The Owner will pay for all initial services of the testing laboratory except as further described in Article 2.01 of this Section.

##### 1.03 QUALITY ASSURANCE

- A. The testing laboratory will be qualified to the Owner's approval in accordance with ASTM E329.
- B. Testing will be in accordance with all pertinent codes and regulations, and with selected standards of the American Society for Testing and Materials.
- C. Owner's Inspector:

An inspector employed by the Owner in accordance with the requirements of California Building Code Amendments will be assigned to the Work. The work of construction in all stages of progress shall be subject to the personal continuous observation of the inspector. He shall have free access to any or all parts of the work at any time. The Contractor shall furnish the inspector reasonable facilities for obtaining such information as may be necessary to keep him fully informed respecting the progress and manner of the work and the character of the materials. Inspection of the work shall not relieve the Contractor from any obligation to fulfill this contract. The inspector and/or Owner shall have authority to stop the work whenever the provisions of the Contract Documents are not being complied with and the Contractor shall instruct his employees accordingly.

##### 1.04 OWNER NOTIFICATION

- A. The Contractor shall notify the Owner's representative a sufficient time in advance of the manufacture of material to be supplied by him under the Contract Documents, which must be tested according to the terms of the Contract, in order that the Owner may arrange for the testing of same at the source of supply.

- B. Any material shipped by the Contractor from the source of supply prior to having satisfactorily passed such testing and inspection or prior to the receipt of notice from said representative that such testing and inspection will not be required and shall not be incorporated in the job.

1.05 TEST REPORTS

A copy of all test reports shall be forwarded to both the Owner and the Architect by the testing agency. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory. Samples taken but not tested shall also be reported. Records of special sampling operations as required shall also be reported. The reports shall show that the material or materials were sampled and tested in accordance with the requirements of the current California Building Code and with the approved specifications. Test reports shall show the specified design strength. They shall also state definitely whether or not the material or materials tested comply with requirements of the Contract Documents.

**PART 2 – PRODUCTS/SERVICES**

2.01 PAYMENTS FOR TESTING INVOLVING NON-COMPLIANCE

When initial tests indicate non-compliance with the Contract Documents, the costs of initial tests as well as costs of subsequent retesting occasioned by the non-compliance will be paid by the Owner and the amount deducted from the Contract Sum.

2.02 SPECIFIC TESTS AND INSPECTIONS

- A. Provide all tests and inspections required by the current California Building Code, required by provisions of the Contract Documents, and such other tests and inspections as are dictated by the Architect.
- B. Tests include, but are not necessarily limited to, those described in detail in Part 3 of this Section.

**PART 3 – EXECUTION**

3.01 TAKING SPECIMENS

The testing personnel, unless otherwise provided in the Contract Documents, shall take all specimens and samples for testing. The testing laboratory will provide all sampling equipment and personnel. The testing laboratory will perform all deliveries of specimens and samples to the testing laboratory.

3.02 COOPERATION WITH TESTING LABORATORY

Provide access to the Work at all times and at all locations where the Work is in progress. Provide facilities for such access to enable the laboratory to perform its functions properly.

3.03 SOIL INSPECTING AND TESTING

- A. Make required inspections and tests including, but not limited to:
1. Visually inspect on-site and imported fill and backfill, making such tests and retests as are necessary to determine compliance with the Contract requirements and suitability for the proposed purpose.
  2. Make field density tests on samples from in-place material as required.
  3. As pertinent, inspect and test the scarifying and recompacting of cleaned subgrade; inspect the progress of excavating, filling, and grading; make 90% density tests at fills and backfills; and verify compliance with provisions of the Contract Documents and governmental agencies having jurisdiction.

B. Make and distribute necessary reports and certificates.

3.04 CONCRETE TESTING AND INSPECTIONS

A. General: Concrete testing and inspection shall comply with Chapter 19 requirements for "Testing and Inspection," California Building Code, Current Edition.

B. Portland cement:

1. Secure from the cement manufacturer Certificates of Compliance delivered directly to the concrete producer for further delivery directly to the testing laboratory.
2. Require the Certificates of Compliance to positively identify the cement as to production lot, bin or silo number, dating and routing of shipment, and compliance with specified standards.
3. If so required by the Architect, promptly provide such other specific physical and chemical data as requested.
4. One sample shall be taken for each 100 tons of cement except that when used in bulk loading ready-mix plants where separate bins for pre-tested cement are not available, grab samples shall be taken for each shipment of cement placed in the bin with not less than one sample being taken for each day's pour and such samples shall be subsequently tested if required by the Architect, Structural Engineer (or the Office of the State Architect.)

C. Aggregate:

1. Provide on test unless character of material changes, material is substituted, or additional test as requested by the Architect.
2. Sample from conveyor belts or batching gates at the ready-mix plant:
  - a. Sieve analysis to determine compliance with specified standards and grading;
  - b. Specific gravity test for compliance with specified standards.

D. Laboratory design mix:

1. Laboratory design mix shall comply with Structural Engineers requirements as stated in Section 32 13 13 and 03 30 00 as found in these specifications.
2. After acceptance of aggregate, and whenever character or source of materials is changed, provide mix design in accordance with ACI 613.
3. Provide designs for all mixes prepared by a licensed Civil Engineer registered in the State of California.

E. Molded concrete cylinders:

1. Provide four test cylinders for each 50 cubic yards, or fraction thereof, of each class of concrete of each day's placement.
2. Test one cylinder at seven days, one at 28 days, and one when so directed.
3. Report the mix, slump, gage, location of concrete in the structure, and test results.
4. Take specimens and make tests in accordance with the applicable ASTM standard specifications.

F. Core tests:

1. Provide only when specifically so directed by the Architect because of low cylinder test results.



2. Cut from locations directed by the Architect, securing in accordance with ASTM C42, and prepare and test in accordance with ASTM C39.
3. Cores shall be of a diameter determined by the Testing Laboratory but no less than 4" in diameter.

G. Placement inspections:

1. The Owner's Inspector shall inspect placement of concrete.
2. Throughout progress of concrete placement, make slump tests to verify conformance with specified slump.
3. Using all required personnel and equipment, throughout progress of concrete placement verify that finished concrete surfaces will have the level or slope that is required by the Contract Documents.
4. A project record shall be kept on the time and date of placing concrete in each portion of the structure. Such record shall be kept until the completion of the structure and shall be open to inspection by the Owner and his Representatives.

H. Batch plant inspections:

The quality and quantity of materials used in transit mixed concrete and in batched aggregate shall be continuously inspected at the location where materials are measured by a specifically approved inspector.

3.05 MORTAR AND GROUT TESTS

- A. General: Mortar and grouts tests shall comply with Chapter 21 requirements of the California Building Code, Current Edition, for "Tests and Inspections."
- B. At the beginning of all masonry work, at least one test sample of the mortar and grout shall be taken on three successive working days and at least one-week intervals thereafter. The samples shall be continuously stored in moist air until tested. They shall meet the minimum strength requirement given in Section 04 05 13 of these Specifications.
- C. Additional samples shall be taken whenever any change in materials or job conditions occur, or whenever in the judgment of the Architect, Structural Engineer (or the Division of the State Architect), such tests are necessary to determine the quality of the material.

3.06 CONCRETE REINFORCEMENT INSPECTION AND TESTING

- A. General: Concrete reinforcement inspection and testing shall comply with Chapter 19 requirements for "Inspections of Welded Reinforcement Bars," California Building Code, Current Edition.
- B. Prior to use, test all reinforcement steel bars for compliance with the specified standards.
  1. Where samples are taken from bundles delivered from the mill, with the bundles identified as to heat number, and provided the mill analysis accompanies the report, then, one tensile test and one bend test shall be made on a specimen from each 10 tons or fraction thereof for each size of reinforcing steel.
  2. Tag identified steel at the supplier's shop. When steel arrives at the job site without such tags, test it as unidentified steel.
- C. Unidentified Steel:
  1. Unidentified steel is considered rejected material. It shall not be brought to the site nor incorporated into the Work. If the rejected material is discovered at the site, it shall be immediately removed from the site.
- D. Provide continuous inspection for all welding of reinforcement steel.

### 3.07 STRUCTURAL STEEL INSPECTING AND TESTING

- A. Prior to use, test all structural steel for compliance with the specified standards.
  - 1. Material identified by mill test reports, and certified by the testing laboratory, does not require additional testing. Require the supplier to furnish mill test reports to the laboratory for certification.
  - 2. Tag identified steel at the supplier's shop. When steel arrives at the job site without such tags, test it as unidentified steel.
- B. Unidentified Steel:
  - 1. Unidentified steel is considered rejected material. It shall not be brought to the site nor incorporated into the Work. If the rejected material is discovered at the site, it shall be immediately removed from the site.
- C. Shop Welding:
  - 1. Provide qualified testing laboratory inspector. The jurisdictional authority shall approve inspector.
  - 2. On single pass welds, inspect after completion of welding prior to painting.
  - 3. On multiple pass welds, and on butt welds with cover pass on the backside, provide continuous inspection.
- D. Field Welding: Provide continuous inspection by a qualified testing laboratory inspector. The jurisdictional authority shall approve inspector.

### 3.08 ROOFING AND WATERPROOFING INSPECTING AND TESTING

- A. Prior to start of membrane waterproofing and roofing installation, conduct a job site meeting attended by representatives of the installing subcontractors, the Contractor's field superintendent, the testing laboratory inspector, and the Architect, to agree upon procedures to be followed.
- B. Prior to start of installation, verify that the materials at the job site comply with the specified standards, that the subcontractor is qualified to the extent specified, and that the installing personnel are fully informed as to procedures to be followed.
- C. During installation, verify that materials are installed in strict accordance with the manufacturers' recommendations as accepted by the Architect.
- D. When so directed by the Architect, make test cuts to verify conformance with the specified requirements.

### 3.09 SCHEDULES FOR TESTING

- A. Establishing schedule:
  - 1. By advance discussion with the testing laboratory selected by the Owner, determine the time required for the laboratory to perform its tests and to issue each of its findings.
  - 2. Provide all required time within the construction schedule.
- B. Adherence to schedule: When the testing laboratory is ready to test according to the established schedule, but is prevented from testing or taking specimens due to incompleteness of the Work, all extra charges for testing attributable to the delay may be back-charged to the Contractor and shall not be borne by the Owner.

3.10 INSPECTION BY THE OWNER

The Owner or his representative shall at all times have access to the shops wherein Work is being fabricated or assembled and inspection is required. The Contractor shall provide safe access for such inspection.

**END OF SECTION**

NOT FOR BID

## SECTION 01 50 00

### CONSTRUCTION FACILITIES

#### PART 1 – GENERAL

##### 1.01 SECTION INCLUDES

- A. Furnishing and installing required temporary facilities as indicated and/or specified as required for proper performance and execution of each Trade Contractor's Contract.
- B. Related documents include the General Conditions and Supplemental Conditions.
- C. This applies to all trades unless noted otherwise.

##### 1.02 REGULATORY REQUIREMENTS

- A. Comply with governing regulations and utility company regulations and recommendations.
- B. Comply with pollution and environmental protection regulations for use of water and energy, for discharge of wastes and storm drainage from Project Site, and for control of dust, air pollution and noise.
- C. Temporary construction shall conform to requirements of State, County, and Local authorities and underwriters which pertain to operation, health, safety, and fire hazard. Contractor shall furnish and install items necessary for conformance with such requirements, whether or not called for under the separate divisions of these specifications.

##### 1.03 TEMPORARY WATER

- A. **The Plumbing and Site Utilities Bid Category Contractor** will ensure there are hose bibs on-site that are operational for the use by the trades during construction. Cost of the water to be paid for by the owner. In the event water from a hydrant is needed, the trade needing the hydrant water will obtain a water meter/backflow preventer for their use. The cost of the water, the meter and backflow will be the responsible of the trade needed the hydrant water. Water source will be from the nearest hydrant. It will be the Prime Contractor's responsibility to transport construction water from the water source to the construction site.
- B. Trade Contractor shall only use water from the designated location. Building facility may be used **IF** temporary water is available.

##### 1.04 TEMPORARY SANITARY FACILITIES

- A. Temporary chemical type toilet facilities and enclosures will be provided.
- B. Building facilities **will not** be used.

##### 1.05 FENCES AND BARRICADES

Temporary fencing, a minimum six feet high with locked entrance gates to enclose the Work will be provided to deter unauthorized entry, vandalism and/or theft.

Any Trade Contractor requiring fencing above and beyond what is being provided by the Construction Manager for execution of their work, shall furnish, install and maintain same as required.

- A. The County will not provide a security service. If the County opts to provide construction cameras for limited security, the County and Construction Manager shall be held harmless by Prime Contractors and their subcontractors for any and all materials, equipment, tools, etc. which may be stolen, vandalized, or found missing.
- B. Refer to Appendix "C" for site fencing and logistics.

1.06 TEMPORARY TELEPHONE SERVICE

- A. The County will not provide a phone at the site for Trade Contractor's use. Each contractor shall provide their own cell phone and service.

1.07 CONSTRUCTION EQUIPMENT

- A. Trade Contractor shall erect, equip, and maintain construction equipment in strict accordance with applicable statutes, laws, ordinances, and regulations of authority having jurisdiction.
- B. Trade Contractor shall provide, maintain, and move upon completion of the Work, all temporary rigging, scaffolding, hoisting equipment, rubbish chutes, ramps, stairs, runways, platforms, ladders, railings, and other temporary construction as required for all work hereunder.

1.08 STORAGE

- A. Operations of the Trade Contractor, including storage of materials, shall be confined to areas approved by Construction Manager. Trade Contractor shall be liable for damage caused by him during such use of property of the County or other parties. Trade Contractor shall hold the County, Program Manager and Construction Manager along with their respective officers, employees and agents, and the Architect and his employees, free and harmless from liability of any nature or kind arising from any use, trespass, or damage caused by his operations on premises of third persons. Storage facilities shall provide protection of products from excessive cold, heat, moisture, humidity, or physical abuse as specified in the respective sections for the products stored. Each Contractor requiring same shall provide their own temporary storage and security for same.
- B. Include cost to move storage bins, trailer, equipment, tools, and materials at storage area at least once for construction phasing.
- C. Refer to the construction schedule for when areas are scheduled to be improved and may require storage bins to be removed. Contractor may need to consider other alternatives for storage if space does not permit.
- D. Any contractor providing storage for their materials and/or performing staging operations will provide the necessary protection to prevent damage to the existing surfaces.

1.09 TEMPORARY JOB OFFICE

- A. The Construction Manager will provide a temporary job office for the Construction Manager's use only. Trade Contractor requiring office space shall provide same ***IF*** space permits. All temporary job offices shall be coordinated with the Construction Manager prior to said office being stored onsite. If a temporary office trailer is permitted for contractor use, the County is not responsible for providing power distribution or phone service to said trailer.
- B. Temporary office for County's Inspector shall be provided by the County in accordance with the General Conditions.

1.10 TEMPORARY ELECTRICAL

- A. Temporary construction power will be provided by **Electrical Bid Category Contractor**.
  - 1. One 200 amp single phase service.
  - 2. Temp power boxes ran from the 200 amp service placed every 100 foot. A minimum of 4 boxes will be required.
  - 3. Any temporary power requirements beyond these provided will be the responsibility of the Contractor requiring same.
  - 4. All welding will be done with self-contained gas powered units.
  - 5. Each Trade Contractor to provide generator power for their operations until temporary power is available or at areas where temporary is not scheduled to be

provided.

1.11 TEMPORARY LIGHTING

- A. Temporary Lights for general illumination is to be furnish, installed, and maintained by the **Electrical Bid Category Contractor**. Each Trade Contractor shall be responsible to provide and maintain all task lighting as required to perform their scope of work. Each Trade will also be required to re-install and/or replace any of the general illumination lighting installed by the Electrical Bid Category Contractor that the Trade Category Contractor takes down, relocates, modifies, etc.

1.12 TEMPORARY HEAT

- A. Temporary heat will be supplied and maintained by the Trade Contractor requiring same.
- B. Do not use permanent equipment for temporary heating purposes unless specifically noted otherwise in the Contract Documents.

1.13 TEMPORARY VENTILATION

- A. All Contractors shall ventilate enclosed areas to assist cure of materials, dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases as the above may be generated by them.

1.14 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- C. Provide protection for plant life and trees designated to remain and for soft and hardscape areas adjacent to work, replace damaged materials as directed by the Architect.
- D. Protect owner-owned, vehicular traffic, stored materials, site and structures from damage.
- E. Construction workers who communicate with students or staff, except in emergency or safety related situations will be immediately removed from the site.
- F. Protect adjacent finishes, and adjacent property from damage.

1.15 NOISE CONTROL

- A. Provide methods, means, and facilities for noise control. Comply with all local ordinances.
- B. Personal AM/FM radios, iPods, MP3 players, and other media devices are not permitted.

1.16 POLLUTION CONTROL

- A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.
- B. Provide dust control during Trade Contractors operations and continuously until such time that Work is substantially complete.

1.17 EXTERIOR ENCLOSURES

- A. Provide temporary weather-tight closure of exterior openings to accommodate acceptable working conditions and protection for materials, to allow for temporary heating and maintenance or required ambient temperatures identified in individual
- B. Specification Sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.18 ACCESS ROADS

- A. Provide and maintain access to fire hydrants, free of obstructions.
- B. Designated existing on-site roads may be used for construction traffic.
- C. Refer to temporary fencing plan for construction entrances.

1.19 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

Each Trade Contractor onsite shall participate in a weekly cumulative Project clean-up at a minimum one (1) hour every Friday. This will require one (1) worker per trade to participate weekly as directed by the Construction Manager. If a trade does not participate, one worker will be appointed on the trade's behalf at a rate of \$125/hour in addition to management and administrative costs.

- B. Each applicable Trade Contractor shall remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to the space being enclosed.
- C. Each applicable Trade Contractor shall broom and vacuum clean interior areas prior to start of surface finishing and continue cleaning to eliminate dust.
- D. Remove waste materials, debris, and rubbish from site periodically and legally dispose off-site.

1.20 PROJECT IDENTIFICATION

- A. A project identification sign may be installed by Construction Manager.
- B. No other signs will be permitted.

1.21 STAGING AREAS

- A. Coordinate with Construction Manager for location, extent and type of construction staging area.

1.22 PARKING

- A. The site is limited in size. Short of unloading of materials, equipment, and crews, on-site parking will not be available. Parking will be off-site on the public street.

1.23 GRAFFITI / VANDALISM

- A. Graffiti / vandalism will not be tolerated on any existing or new structure including temporary toilets. Anyone caught defacing any structure will be immediately removed from the site.
  - 1. Temporary toilets with graffiti or those that have been vandalized will be replaced. The expense associated with the replacement will be distributed among all the Trade Contractors on-site.
  - 2. Each Trade Contractor has the sole responsibility of protecting their own work until such work has been accepted by the Owner. Trade Contractor shall be responsible to make all necessary repairs, at their expense, to finish work that has been damaged by graffiti and/or vandalism not accepted by the Owner. The trade contractor shall cover or remove graffiti on their work the day it is discovered.

1.24 NOT USED

1.25 STAFF AND CREW REQUIREMENTS

- A. Staffing Requirements
  - a. Trade Contractor shall provide the staffing necessary to ensure the Project is not

impacted as a result of being under staffed. Contractor must provide one qualified superintendent, with no less than 5 years of school construction experience.

**B. Crew Requirements**

- a. Separate working crews will be required and contractor shall take this manpower into consideration when meeting their schedule obligation.

**1.26 WATER CONSERVATION**

- A. Attention is directed to these specifications which require the use of water for the construction of this project. Attention is also directed to state and local ordinances regarding water conservation and storm drain pollution control measures.
- B. The Contractor shall, whenever possible and not in conflict with the specifications and ordinances, minimize the use of water during construction of the project. Watering equipment, hose, piping and valves shall be kept in good working order; water leaks shall be repaired promptly; and washing of equipment, except when necessary for safety or for the protection of the equipment, shall be discouraged. Wash water from such activities shall not be discharged into storm drains.

**PART 2 - PRODUCTS**

NOT USED

**PART 3 - EXECUTION**

NOT USED

**END OF SECTION**



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## SECTION 01 60 00

### PRODUCT REQUIREMENTS

#### **PART 1 – GENERAL**

##### 1.01 SECTION INCLUDES

A. Following Administrative and Procedural Requirements:

1. Selection of products for use in Project
2. Product delivery, storage, and handling.
3. Manufacturers standard warranties on products.
4. Special warranties.
5. Product substitutions.

##### 1.02 RELATED REQUIREMENTS AND SECTIONS

- A. Instructions to Bidders: Procedures for requesting substitutions during bidding period.
- B. Division 1: Substitution Procedures
- C. Section 01 77 00: Project Closeout Procedures; for submitting warranties for contract closeout.
- D. Divisions 2 through 33 Sections for specific requirements for warranties on products and installations specified to be warranted.

##### 1.03 DEFINITIONS

- A. Products: Items purchased for incorporating into Work, whether purchased for Project or taken from previously purchased stock. The term “product” includes terms material, equipment, system, and terms of similar intent.
1. Named Products: Items identified by manufacturer’s product name, including make or model number or other designation, shown or listed in manufacturer’s published product literature that is current as of date of Contract Documents.
  2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise.
    - a. Products salvaged or recycled from other projects are not considered new products.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction required by Contract Documents and proposed by Contractor; following are not considered substitutions:
1. Substitutions requested during bidding period, and accepted by written Addendum prior to opening of bids or award of Contract.
  2. Revisions to Contract Documents requested by Owner or Architect.
  3. Specified options of products and construction methods included in Contract Documents.
  4. Compliance with governing regulations and orders issued by governing authorities.
- C. Basis-of-Design Product Specification: Where specific manufacturer’s product is named and accompanied by words “Basis of Design”, including make or model number or other designation, to establish significant qualities related to type, function, dimension, in-service

performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers. If only one manufacturer is named, it shall be considered the Basis of Design whether designed as the Basis of Design or not.

- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for particular product and specifically endorsed by manufacturer to Owner.
- E. Special Warranty: Written warranty required by or incorporated into Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

#### 1.04 SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration.

Refer to Specification Section 01 25 00 for Substitution Procedures. The clauses in this Specification is intended to complement the requirements of Specification Section 01 25 00. Where the clauses are in conflict, the more stringent of the two shall apply.

1. Identify product or fabrication or installation method to be replaced.
2. Include Specification Section number and title and Drawing numbers and titles.
  - a. Refer to Article 2.02, in this Section.
3. Substitution Request Form: Use form provided the **architect**; other forms will not be accepted.
  - a. Requests received without properly completed substitution request form will be rejected without further review.
4. Documentation: Show compliance with requirements for substitutions and following, as applicable:
  - a. Statement indicating why specified material or product cannot be provided.
  - b. Product identification, including manufacturer's name and address.
  - c. Coordination information, including list of changes or modifications needed to other parts of Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
  - d. Detailed comparison of significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  - e. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - f. Structural calculations, where applicable or requested, prepared and signed by Structural Engineer licensed in California.
  - g. Samples, where applicable or requested.
  - h. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
  - i. Material test reports from qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - j. Research/evaluation reports evidencing compliance with building code in effect for Project, from model code organization acceptable to authorities having jurisdiction.
  - k. Detailed comparison of Contractor's Construction Schedule using proposed

substitution with products specified for Work, including effect on overall Contract Time.

- 1) If specified product or method of construction cannot be provided within Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.

- l. Cost information, including proposal of change, if any, in Contract Sum.
- m. Designation of availability of maintenance services, sources of replacement materials.
- n. Contractor's certification that proposed substitution complies with requirements in Contract Documents and is appropriate for applications indicated.
- o. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00.

1. Show compliance with requirements.

#### 1.05 QUALITY ASSURANCE

A. To fullest extent possible, provide products of same kind, from single source.

#### 1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle products using means and methods that will prevent damage, deterioration and loss, including theft; comply with manufacturer's written instructions.

1. Schedule delivery to minimize long term storage at Project Site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other losses.
3. Deliver products to Project Site in undamaged condition in manufacturer's original sealed container, or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting and installing.
4. Inspect products on delivery to ensure compliance with Contract Documents, and to ensure products are undamaged and properly protected.
5. Store products in manner to facilitate inspection and measurement of quantity or counting of units.
6. Store materials in manner that will not endanger Project structure.
7. Store products subject to damage by elements under cover in weathertight enclosure above ground, with ventilation adequate to prevent condensation.
8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
9. Protect stored products from damage.

#### 1.07 PRODUCT WARRANTIES

1. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by Contract Documents.

1. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.
2. Special Warranties: Prepare written document that contains appropriate terms and identification, ready for execution.
  1. Submit draft for approval before final execution.
  2. Manufacturer's Standard Form: Modified to include Project specific information and properly executed.
  3. Refer to Division 2 through 33 Sections for specific content requirements and particular requirements for submitting special warranties.
3. Submittal Time: Comply with requirements in Section 01 77 00.

## **PART 2 – PRODUCTS**

### **2.01 PRODUCT SELECTION**

- A. General: Provide products that comply with Contract Documents, are undamaged, and unless otherwise indicated, that are new (not previously installed) at time of installation.
  1. Provide products complete with accessories, trim, finish, fasteners, safety guards and other items needed for complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Owner reserves right to limit selection to products with warranties not in conflict with requirements of Contract Documents.
  4. Where products are accompanied by term "as selected", Architect will make selection.
  5. Where products are accompanied by term "match sample", sample to be matched is Architect's.
  6. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.
  7. Or Equal: Where products are specified by name and accompanied by term "or equal" or "or approved equal" or "or approved", comply with provisions in Product Substitutions Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures: Procedures for product selection include following:
  1. Product: Where Specification paragraphs or subparagraphs titled Product name single product and manufacturer, provide product named.
    - a. Substitutions may be considered, unless otherwise indicated.
  2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled Manufacturer or Source name single manufacturers or sources, provide product by manufacturer or from source named that complies with requirements.
    - a. Substitutions may be considered, unless otherwise indicated.
  3. Products: Where Specification paragraphs or subparagraphs titled Products introduce list of names of both products and manufacturers, provide one of products listed that complies with requirements.
    - a. Where products or manufacturers are specified by name, accompanied by term "or equal", or "or approved equal" comply with provisions in "Product Substitutions" Article to obtain approval for use of an unnamed product.

4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce list of manufacturers names, provide product by one of manufacturers listed that complies with requirements.
  - a. Where manufacturers are specified by name, accompanied by term "or equal", or "or approved equal" comply with provisions in Product Substitutions Article to obtain approval for use of an unnamed product.
5. Product Options: Where Specification paragraph titled Product Options indicate that size, profiles, and dimensional requirements on Drawings are based on specific product or system, provide either specific product or system indicated or comparable product or system by another manufacturer.
  - a. Comply with provisions in Product Substitutions Article to obtain approval for use of unnamed product and/or manufacturer.
6. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled Basis-of-Design Product are included and also introduce or refer to list of manufacturers names, provide either specified product or comparable product by one of other named manufacturers.
  - a. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on product named.
  - b. Comply with provisions in Product Substitutions Article to obtain approval for use of unnamed product.
  - c. Substitutions may be considered.
7. Visual Matching Specification: Where Specifications require matching established Sample, select product and manufacturer that complies with requirements and matches Architect's sample.
  - a. Architect's decision will be final on whether proposed product matches satisfactorily.
  - b. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of Contract Documents on substitutions for selection of matching product.
8. Visual Selection Specification: Where Specifications include phrase as selected from manufacturer's colors, patterns, textures, or similar phrase, select product and manufacturer that complies with other specified requirements.
  - a. Standard Range: Where Specifications include phrase standard range of colors, patterns, textures or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that does not include premium items.
  - b. Full Range: Where Specifications include phrase full range of colors, patterns, textures or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.
9. Performance Specification Requirements: Where Specifications require compliance with performance requirements, provide products that comply with requirements, and are recommended by manufacturer for application indicated.
  - a. General overall performance of product is implied where product is specified for specific application.
  - b. Manufacturer's recommendations may be contained in product literature, or by manufacturer's certification of performance.

## 2.02 PRODUCT SUBSTITUTIONS

- A. Timing: Substitutions are restricted to before bid opening if stated in the bidding documents. Acceptable substitutions prior to bid shall be communicated **ONLY** through addenda.
1. Requests for substitutions received after that time may be considered or rejected at discretion of Architect.
  2. Requests for substitutions **MAY** be considered if received within 15 days after award of Contract, subject to specified submittal requirements and following:
    - a. Architect will consider request for substitution after commencement of Work, within 15 days after award of Contract, only if specified product or construction method cannot be provided within Contract Time, cannot receive necessary approvals, cannot be provided in manner compatible with or coordinate with other materials or cannot provide required warranty.
    - b. Contractor's base bid **MUST** include the specified product. If the substitution is accepted after the Notice of Award, the owner receives full benefit of the cost reduction.
    - c. Requests received more than 15 days after award of contract will only be considered in case of substantiated product unavailability, or conditions beyond control of Contractor.
- B. Conditions: Contractor's substitution request will be received and considered by Architect when following conditions are satisfied, as determined by Architect; otherwise requests will be returned without action except to record noncompliance with these requirements; burden of proof of merit of proposed substitution is upon proposer.
1. Extensive revisions to Contract Documents are not required Requested substitution is consistent with Contract Documents and will produce indicated results.
  2. Request is timely, fully documented and properly submitted.
  3. Request is directly related to "or equal" clause or similar language in Contract Documents.
  4. Request is directly related to "or equal" clause or similar language in Contract Documents.
  5. Specified product or construction method cannot be provided within Contract Time.
    - a. Request will not be considered if product or method cannot be provided as result of failure to pursue Work promptly, failure to identify items requiring long lead times, or failure to coordinate activities properly.
  6. Specified product or construction method cannot receive necessary approval by governing authority, and requested substitution can be approved.
  7. Substantial advantage is offered Owner, in cost, time, energy conservation, or other considerations of merit, after deducting additional responsibilities Owner must assume.
    - a. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner or separate Contractors, and similar considerations.
  8. Specified product or construction method cannot be provided in manner that is compatible with other materials, and where Contractor certifies that requested substitution will overcome incompatibility.
  9. Specified product or construction method cannot be coordinated with other materials, and where Contractor certifies that requested substitution can be coordinated.

10. Specified product or construction method cannot provide warranty required by Contract Documents and where Contractor certifies that requested substitution provide required warranty.
  11. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of Work, is uniform and consistent, is compatible with other products, and is acceptable to contractors involved.
- C. Architects Action: If necessary, within one week of receipt of request for substitution, Architect will request additional information or documentation for evaluation of request for substitution.
1. Within 2 weeks of receipt of request, or one week of receipt of additional information or documentation, whichever is later, Architect will notify Contractor of acceptance or rejection of requested substitution.
  2. Use product specified if Architect cannot make decision on use of proposed substitution within time allocated.
  3. Architect will not be responsible for locating or securing information which is not included in substantiating data.
  4. Architect's decision of acceptance or rejection of requested substitution shall be final.
- D. Architect's cost for evaluating substitutions requested by Contractor, including making subsequent revisions to drawings, specifications and other resulting documentation, will be paid by Owner with reimbursement from Contractor by deductive change order.
- E. Contractor's submittal and Architect's acceptance of Shop Drawings, Product Data or Samples that relate to construction activities not complying with Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval.
- F. Forms of Acceptance for Substitutions:
1. During Bidding Process: Addendum
  2. After Award of Contract: Change Order.

### **PART 3 – EXECUTION**

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## SECTION 01 66 00

### PRODUCT STORAGE AND HANDLING REQUIREMENTS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 DESCRIPTION

Work Included: Provide products scheduled for use in the Work by means including, but not necessarily limited to, those described in this Section.

##### 1.03 QUALITY ASSURANCE

Include within the Contractor's quality assurance program such procedures as are required to assure full protection of work and materials.

##### 1.04 MANUFACTURERS' RECOMMENDATIONS

Except as otherwise accepted by the Architect, determine and comply with manufacturers' recommendations on product handling, storage, and protection.

##### 1.05 PACKAGING

A. Deliver products to the job site in their manufacturer's original container, with labels intact and legible.

1. Maintain packaged materials with seals unbroken and labels intact until time of use.

2. Promptly remove damaged material and unsuitable items from the job site, and promptly replace with materials meeting the specified requirements, at no additional cost to the Owner.

B. The Architect may reject as non-complying such material and products that do not bear identification satisfactory to the Architect as to manufacturer, grade, quality, and other pertinent information.

##### 1.06 PROTECTION

A. Protect finished surfaces, including jambs and soffits of openings used as passageways, through which equipment and materials are handled.

B. Provide protection for finished floor surfaces in traffic areas prior to allowing equipment or materials to be moved over such surfaces.

C. Maintain existing surfaces to remain and finished surfaces clean, unmarred, and suitably protected until accepted by the Owner.

##### 1.07 REPAIRS AND REPLACEMENTS

A. In event of damage, promptly make replacements and repairs to the acceptance of the Architect and at no additional cost to the Owner.

B. Additional time required to secure replacements and to make repairs will not be considered by the Architect to justify an extension in the Contract Time of Completion.

**END OF SECTION**

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## SECTION 01 71 23

### FIELD ENGINEERING

#### **PART 1 – GENERAL**

##### 1.01 REQUIREMENTS INCLUDE:

- A. Quality control
- B. Field engineering & staking is to be furnished and paid for by the General Contractor as identified below.
- C. Field engineering & staking in addition to what is identified below to be paid for by the General Contractor or Sub-Contractor requiring same.
- D. Survey reference points
- E. Staking requests and procedures

##### 1.02 QUALITY CONTROL

- A. In order to maintain continuity, clarity, and simplicity throughout the course of the project, ALL surveying, staking and field engineering listed in item 1.3 below will be provided by the General Contractor. Said surveying shall be performed by a certified licensed surveyor.
- B. It is the General Contractor or Sub-Contractor's responsibility to understand, double check, and verify the placement of the stakes prior to beginning work and notify the Construction Manager of any discrepancies, questions, and/or problems before proceeding with the work. Staking will be performed once. The maintenance of the stakes for the General Contractor who has requested / required said staking shall be the responsibility party. Cost to replace lost, damaged, and/or negligence is at the expense of the General Contractor. The General Contractor will provide any additional surveying, staking, and field engineering he requires at his expense.

##### 1.03 FIELD ENGINEERING & STAKING FURNISHED AND PAID FOR BY CONTRACTOR

- A. PROPERTY BOUNDARIES (if applicable)
  - 1. Property lines
  - 2. Property corners
- B. ROUGH GRADE STAKING
  - 1. Swales.
  - 2. Ridge lines.
  - 3. Establish temporary bench control.
  - 4. Site at 50 ft. grid, grade breaks, angle points, B.C.'s and E.C.'s.
  - 5. Building pad corners (establish pad finish and/or subgrade elevations).
  - 6. Layout of all depressions for floor finishes.
  - 7. Post rough grade survey.
    - a. Establish and record 25 topo points for contour confirmation.
    - b. Establish and record 100 topo points around and in between buildings and paving and hardscape areas to establish existing grades prior to start of site and building improvements.
- C. FOUNDATION CONSTRUCTION
  - 1. Establish horizontal and vertical control.
  - 2. Building pad certification and As-builts for Owner.

3. Layout of building and canopy structure - perimeter and major grid lines for line only, and all radius points.
4. Bench marks at building (for vertical control). Two (2) each per building at opposite corners, as directed by the Construction Manager.
5. Over Excavation: Vertical & Horizontal location

D. STORM DRAIN SYSTEM

1. Staked at +/- 25' intervals. (Lines & Grades)
2. Catch basins.
3. Manholes; including rim & invert elevations.
4. Drainage structures, angle points, transitions, manholes, and inlets.
5. Invert elevations at all grade breaks.
6. Bio Retention Basins

E. CURB, CURB & GUTTER, "V" GUTTER

1. Set stakes at +/- 50' centers.
2. Beginning of curve and /or radius.
3. End of curve and/or radius.
4. Grade breaks.
5. Angle points.
6. Radius points.
7. Curb and gutter, cross gutter, v-gutter, swales, aprons, drive approaches headers, B.C.'s E.C.'s grade breaks and curb face/local depressions.

F. SEWER / ELECTRIC STAKES

1. Manholes; including rim & invert elevations.
2. Sewer main (25 ft. intervals-line and grade), manholes, cleanouts, angle points, grade breaks and laterals.
3. Stake main utility lines and all vaults.

G. DOMESTIC, FIRE WATER & GAS LINES

1. +/- 50' intervals – line and grade, angle points, laterals, appurtenance, and devices.

H. RETAINING / PLANTING / SEAT WALL STAKING

1. +/- 50' intervals, angle points, and radius points.
2. Top of wall.
3. Top of footing.

I. SITE & OFF-SITE WORK STAKES

1. Redwood header and edge of pavement at 25 ft. intervals.
2. Light standards - two stakes each.
3. Site certification and As-Builts for Owner.
5. Subgrade staking for site concrete, asphalt paving, ramps and stairs.
6. Chain link and ornamental fencing and gate – line and grade.
7. Temporary power pole locations.
8. Flagpoles

9. Fountains

J. CUT SHEETS PROVIDED DAILY

1. Provide cut sheets after each survey, no later than the close of business the same day.

1.04 FIELD ENGINEERING & STAKING TO BE PAID FOR BY THE CONTRACTOR REQUIRING SAME

- A. Any and all required field engineering and staking which is not specifically noted as being furnished by the General Contractor or Sub-Contractor above, must be done by the General Contractor's surveyor and paid for by the General Contractor or applicable Sub-Contractor requiring and/or requesting same. The General Contractor may have additional surveying done by the Sub-Contractor, a licensed land surveyor, or a registered civil engineer at his expense.

1.05 SURVEY REFERENCE POINTS

- A. Each Sub-Contractor shall locate and protect survey control and reference points.
- B. Control datum for survey is that established by the General Contractor or applicable Sub-Contractor.
- C. The applicable Sub-Contractor shall protect survey control points prior to starting site work; preserve permanent reference points during construction.
- D. Promptly report to the Construction Manager's job site Superintendent the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
- E. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice from the Architect through the Construction Manager.

1.06 STAKING REQUESTS AND PROCEDURES

- A. All staking request shall be made in writing through the Construction Manager's Project Superintendent a **MINIMUM of 48 HOURS** prior to need of staking. Should the area to be staked be found not ready or clear for staking, or the requested staking date changed, the surveyor shall have up to 48 hours additional time to begin work.
- B. Staking requests shall be made for a minimum of 8 hours of survey time per request, unless Surveyor and the General Contractor or applicable Sub-Contractor mutually agree to a shorter requested time per request.
- C. Arrangement and payment for any and all staking (done by the General Contractor or applicable Sub-Contractor) not specifically included in item 1.03 above, shall be made as follows:
  1. Lump sum quote
    - a. The General Contractor shall request a lump sum quotation in writing from the Sub-Contractor's Surveyor through the Construction Manager for the specific staking required.
    - b. The Sub-Contractor shall provide a written lump sum quotation to the General Contractor through the Construction Manager for the requested work.
    - c. If acceptable, the General Contractor shall sign quote and submit to the Construction Manager for processing. If unacceptable, the General Contractor shall negotiate final price with the Sub-Contractor or authorize **the Sub-Contractor's** Surveyor to proceed on an hourly rate basis as noted below. Construction Manager shall endeavor to assist the General Contractor to ensure that **ALL** lump sum quotes from Sub-Contractor's Surveyor are competitive.
  2. Hourly rate
    - a. The General Contractor or Sub-Contractor shall request the specific staking required in writing through the Construction Manager on a form provided by the Sub-Contractor shall sign this request.
    - b. Construction Manager shall forward staking request on to the General Contractor.
    - c. The Sub-Contractor's Surveyor shall perform requested work and shall record survey and staking time on the Sub-Contractor's signed staking request form.

- d. Sub-Contractor's Surveyor shall present staking request form to the Sub-Contractor for a second signature to document survey hours each day the work is performed for the Sub-Contractor to sign. The Sub-Contractor is urged to remain on the site during the survey work and to sign for their own daily survey work, however, if Sub-Contractor's Foreman is not on the project at the completion of the Surveyor's staking, then the Sub-Contractor automatically authorizes the Construction Manager's Superintendent or General Contractor to sign on Sub-Contractor's behalf to document the hours charged for the day.
- 3. The General Contractor or Sub-Contractor shall pay the Surveyor direct for all survey work requested in writing on a monthly basis. All charges for requested staking done by the General Contractor or Sub-Contractor, shall be tallied and automatically deducted from the applicable Sub-Contractor's pay request each month. Upon completion of all requested survey and staking work on the project, Construction Manager shall issue a formal deductive change order to the General Contractor's Contract to provide a final accounting of the staking charges.
- D. Staking requests shall consider continuity of survey work (example).
  - 1. Survey staking of a complete area of site.
  - 2. Survey staking of total sewer/storm drain line or large segments of continuous work.
  - 3. There is no minimum or maximum number of move-ins required by the surveyor to perform their work. However, CM shall attempt to utilize the least amount of move-ins possible.
- E. After the stakes are set, it shall be the General Contractor or Sub-Contractor who requested said staking's sole responsibility to protect the stakes from any damage. Any re-staking shall be charged to the General Contractor or Sub-Contractor who ordered said staking if the party damaging the staking cannot be determined or verified.
- F. Should a discrepancy occur and the Surveyor's stakes are missing, then the Surveyor's field notes shall be relied on as to how the object was staked. A set of field notes will be provided to the Construction Manager and the General Contractor or Sub-Contractor related to the specific staking after the staking is complete. The field notes and the stake markings shall be used together, and any differences shall be immediately brought to the attention of the Construction Manager.
- G. The General Contractor or Sub-Contractor responsible for building foundations shall verify the Surveyor's staking for building layout and immediately notify the Construction Manager of any discrepancies. The Construction Manager will then take the appropriate action. Should said Sub-Contractor fail to make the above verification, he shall assume responsibility for the accuracy of the layout.

**END OF SECTION**

## SECTION 01 73 29

### CUTTING AND PATCHING

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.

##### 1.03 DEFINITIONS

- A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

##### 1.04 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch the following operating elements and related components in a manner that results in reducing their capacity to perform as intended or those results in increased maintenance or decreased operational life or safety.
  - 1. Primary operational systems and equipment.
  - 2. Air or smoke barriers.
  - 3. Fire-protection systems.
  - 4. Control systems.
  - 5. Communication systems.
  - 6. Electrical wiring systems.
- C. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
  - 1. Water, moisture, or vapor barriers.
  - 2. Membranes and flashings.
  - 3. Exterior curtain-wall construction.
  - 4. Equipment supports.
  - 5. Piping, ductwork, vessels, and equipment.
  - 6. Noise- and vibration-control elements and systems.
- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.



#### 1.05 WARRANTY

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

### **PART 2 - PRODUCTS**

#### 2.01 MATERIALS

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

### **PART 3 - EXECUTION**

#### 3.01 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
  - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

#### 3.02 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to minimize interruption of services to occupied areas.

#### 3.03 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size

required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Excavating and Backfilling: Comply with requirements in the technical specifications where required by cutting and patching operations.
  5. Mechanical and Electrical Services: Where directed by drawings or specifications, cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
  3. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition.

**END OF SECTION**

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## SECTION 01 74 00

### CLEANING AND WASTE MANAGEMENT

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 DESCRIPTION

Work Included: Throughout the construction period, maintain the buildings and site in a standard of cleanliness as described in this Section.

##### 1.03 QUALITY ASSURANCE

- A. Conduct daily inspection, and more if necessary, to verify that requirements for cleanliness are being met.
- B. In addition to the standards described in this Section, comply with pertinent requirements of governmental agencies having jurisdiction.

#### **PART 2 – PRODUCTS**

##### 2.01 CLEANING MATERIALS AND EQUIPMENT

Provide required personnel, equipment, and materials needed to maintain the specified standard of cleanliness.

##### 2.02 COMPATIBILITY

Use only the cleaning materials and equipment that are compatible with the surface being cleaned, as recommended by the manufacturer of the material.

#### **PART 3 – EXECUTION**

##### 3.01 PROGRESS CLEANING

###### A. General:

- 1. Retain stored items in an orderly arrangement allowing maximum access, not impeding traffic or drainage, and providing required protection of materials.
- 2. Do not allow accumulation of scrap, debris, waste material, and other items not required for construction of this work.
- 3. At least twice each month, and more often if necessary, completely remove all scrap, debris, and waste material from the job site.
- 4. Provide adequate storage for all items awaiting removal from the job site, observing requirements for fire protection and protection of the ecology.

###### B. Site:

- 1. Daily, and more often if necessary, inspect the site and pick up all scrap, debris, and waste material. Remove such items to the place designated for their storage.
- 2. Weekly, and more often if necessary, inspect all arrangements of materials stored on site. Re-stack, tidy, or otherwise service arrangements to meet the requirements above.
- 3. Maintain the site in a neat and orderly condition at all times.

C. Structures:

1. Weekly, and more often if necessary, inspect the structures and pick up all scrap, debris, and waste material. Remove such items to the place designated for their storage.
2. Weekly, and more often if necessary, sweep interior spaces clean.
  - a. "Clean," for the purpose of this subparagraph, shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and a hand-held broom.
3. As required preparatory to installation of succeeding materials, clean the structures or pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using equipment and materials required to achieve the necessary cleanliness.
4. Following the installation of finish floor materials, clean the finish floor daily (and more often if necessary) at all times while work is being performed in the space in which finish materials are installed.
  - a. "Clean," for the purpose of this subparagraph, shall be interpreted as meaning free from foreign material that, in the opinion of the Architect, may be injurious to the finish floor material.

3.02 FINAL CLEANING

- A. "Clean," for the purpose of this article, and except as may be specifically provided otherwise, shall be interpreted as meaning the level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.
- B. Prior to completion of the Work, remove from the job site all tools, surplus materials, equipment, scrap, debris, and waste. Conduct final progress cleaning as described in Article 3.01 above.
- C. Site:
  1. Unless otherwise specifically directed by the Architect, broom clean paved areas on the site and public paved areas adjacent to the site.
  2. Completely remove resultant debris.
- D. Structures:
  1. Exterior:
    - a. Visually inspect exterior surfaces and remove all traces of soil, waste materials, smudges, and other foreign matter.
    - b. Remove all traces of splashed materials from adjacent surfaces.
    - c. If necessary to achieve a uniform degree of cleanliness, hose down the exterior of the structure.
    - d. In the event of stubborn stains not removable with water, the Architect may require light sandblasting or other cleaning at no cost to the Owner.
  2. Interior:
    - a. Visually inspect interior surfaces and remove all traces of soil, waste materials, smudges, and other foreign matter.
    - b. Remove all traces of splashed material from adjacent surfaces.
    - c. Remove paint drippings, spots, stains, and dirt from finished surfaces.
  3. Glass: Clean inside and outside.

4. Polished surfaces: To surfaces requiring routine application of buffed polish, apply the polish recommended by the manufacturer of the material being polished.
- E. Schedule final cleaning as accepted by the Architect to enable the Owner to accept a completely clean Work.

3.03 CLEANING DURING OWNER'S OCCUPANCY

- A. Prior to the Owner occupying the Work or any portion thereof prior to the completion of the total project by the Contractor, the Contractor shall perform final cleaning for the area to be turned over in accordance with the General Requirements of the Contract.
- B. The Owner and Architect shall walk the limits of the area to be occupied and determine a punch list with expressly identified limits of area to be released. Once the area is accepted and occupied, the contractor shall be released from general cleaning except as required by the completion of the punch list items.

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## SECTION 01 77 00

### PROJECT CLOSEOUT

#### **PART 1 – GENERAL**

##### 1.01 DESCRIPTION

- A. This Section specifies administrative and procedural requirements for project closeout, including but not limited to:
  - 1. Inspection procedures.
  - 2. Project record document submittal.
  - 3. Operating and maintenance manuals submittal.
  - 4. Submittal of warranties.
- B. Closeout requirements for specific construction activities are included in the appropriate Sections in the technical specification sections.
- C. Refer to section 01 99 99 for an acceptable binder cover page template.

##### 1.02 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
  - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price.
    - a. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
  - 2. Advise the Construction Manager of pending insurance change-over requirements.
  - 3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.
  - 4. Obtain and submit releases enabling the District unrestricted use of the Work and access to services and utilities; include occupancy permits, operating certificates and similar releases.
  - 5. Deliver tools, spare parts, extra stock, and similar items.
  - 6. Complete start-up testing of systems, and instruction of the District's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mockups, and similar elements.
  - 7. Complete final clean up requirements.
- B. Inspection Procedures: On receipt of request for inspection, the Architect and/or Engineer will either proceed with inspection or advise the Contractor of unfulfilled requirements. The Architect and/or Engineer will prepare the Certificate of Substantial Completion following inspection, or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
  - 1. The Architect and/or Engineer will repeat inspection when requested and assured that the Work has been substantially completed.
  - 2. Results of the completed inspection will form the basis of requirements for final



acceptance.

### 1.03 RECORD DOCUMENT SUBMITTALS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Architect and/or Engineer's reference during normal working hours.
- B. As-Built Drawings: Produce and maintain a clean, undamaged set of "E" size Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies from the Work as originally shown. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
1. Mark changes to the Documents caused by RFI responses with RFI designation.
  2. Mark changes to the Documents caused by Bulletins with Bulletin designation.
  3. Mark new information that is important to the District, but was not shown on Contract Drawings or Shop Drawings.
  4. Note related Change Order numbers where applicable.
  5. Organize As-Built drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
  6. Per San Bernardino County Building Official Plan Check Requirements, "As- Built" drawing requirements are as follows:
    - As-built drawings are the final set of drawings produced at the completion of a construction project. They include all the changes that have been made to the original construction drawings, including notes, modifications, revisions and any other information that should be included. As-built drawings should not change the design intent but should depict the actual as-built conditions of the completed construction. While the original drawings are typically produced using computer aided design (CAD) software, the as-built drawings should contain handwritten notes, sketches, and changes.
    - When the construction phases of the project / contract are finished a complete set of marked-up redlined drawings will be turned over to EDA Design & Construction for review and approval. All markings shall be on a previous approved set of drawings, signed and stamped by the EOR and Jurisdiction Enforcement Agency. No additional PE seal or signature is required on the as-built drawings. These drawings shall have AS-BUILT DRAWINGS indicated on the title sheet in the title block and on each sheet of submitted as-built drawings along with initial of responsible individual.
- C. Record Specifications: Maintain one complete copy of the Project Manual, including addenda, and one copy of other written Construction Documents such as Change Orders and modifications issued in printed form during construction. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot otherwise be readily discerned later by direct observation. Note related record drawing information and Product Data.
1. Upon completion of the Work, submit record Specifications to the District's Representative for approval and corrections. Upon acceptance, resubmit for the District's use.
- D. Record Product Data: Maintain one copy of each Product Data submittal. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the site, and from the manufacturer's installation instructions and recommendations. Give particular attention to

concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation. Note related Changes Orders and markup of record drawings and Specifications.

1. Upon completion of markup, submit complete set of record Product Data to the District's Representative for approval and correction. Upon acceptance, resubmit for the District's use.
- E. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous recordkeeping and submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the District's Representative for approval and correction. Upon acceptance, resubmit for the District's use.
- F. Maintenance Manuals: Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2 inch, 3-ring vinyl covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Submit one complete set of original manufacturer's maintenance and operational manuals to the District's Representative for approval and corrections. Upon acceptance, resubmit for the District's use a minimum of four (4) complete original manufacturer's sets. Include the following types of information:
  1. Emergency instructions.
  2. Spare parts list.
  3. Copies of warranties.
  4. Wiring diagrams.
  5. Recommended "turn around" cycles.
  6. Inspection procedures.
  7. Shop Drawings and Product Data.
  8. Manufacturer Contact Information
  9. Prime Contractor Contact Information

## **PART 2 - PRODUCTS**

NOT USED

## **PART 3 - EXECUTION**

### **3.01 CLOSEOUT PROCEDURES**

- A. Operating and Maintenance Instructions: Arrange for each installer of equipment that requires regular maintenance to meet with the District's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:
  1. Maintenance manuals.
  2. Record documents.
  3. Spare parts and materials.
  4. Tools.

5. Lubricants.
6. Fuels.
7. Identification systems.
8. Control sequences.
9. Hazards.
10. Cleaning.
11. Warranties and bonds.

**END OF SECTION**

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## SECTION 01 78 36

### WARRANTIES AND BONDS

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.
- B. Refer to the General Conditions for terms of the Contractor's special warranty of workmanship and materials.
- C. Provide one (1) year warranty for workmanship, product and materials **unless** noted differently in the respective specification section.
- D. Certifications and other commitments and agreements for continuing services to the County are specified elsewhere in the Contract Documents.
- E. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- F. Further to Item E above, it is specifically required and acknowledged by this Contractor that warranty periods on all equipment commences from date of **County's acceptance of the equipment and/or from the date of Substantial Completion**, whichever is later. Therefore, startup of equipment and/or the use of equipment during construction shall not be construed as the qualifier for warranty period start.

##### 1.02 DEFINITIONS

- A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the County.
- B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the County.

##### 1.03 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the County has benefited from use of the Work through a portion of its anticipated useful service life.
- D. County's Recourse: Written warranties made to the County are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the County can enforce such other duties, obligations, rights, or remedies.

1. Rejection of Warranties: The County reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- E. The County reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entitles required to countersign such commitments are willing to do so.

#### 1.04 SUBMITTALS

- A. Submit written warranties to the County's Representative prior to the date certified for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.
  1. When a designated portion of the Work is completed and occupied or used by the County, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.
- B. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the County through the County's Representative for approval prior to final execution.
- C. Form of Submittal: At Final Completion compile four (4) copies of each required warranty and bond properly executed by the Contractor, or by the Contractor's subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual. Use a form acceptable to the County.
- D. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8½ inch by 11-inch paper.
  1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
  2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the Project title or name, and the name of the Contractor. Refer to section 01 99 00 for an acceptable closeout cover page template.
  3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

## **PART 2 – PRODUCTS**

NOT USED

## **PART 3 – EXECUTION**

NOT USED

**END OF SECTION**

## SPECIFICATION 01 91 13

### GENERAL COMMISSIONING REQUIREMENTS

#### **PART 1 – GENERAL**

##### 1.01 COMMISSIONING AGENCY

- A. The commissioning agency (CA) has been contracted through the Architect for this project.
- B. The CA has overall responsibility for planning and coordinating the commissioning process. However, commissioning involves all parties to the design and construction process, including the contractor.

##### 1.02 CONTRACTOR RESPONSIBILITY

- A. This Section of the specifications defines the contractor's responsibilities with respect to the commissioning process. Each contractor and sub-contractor shall review this Section, and shall include in their bids for carrying out the work described, as it applies to each Division and Section of these specifications, individually and collectively.

##### 1.03 DESCRIPTION OF WORK

- A. The purpose of the commissioning process is to provide the owner/operator of the facility with assurance that the mechanical and electrical systems have been installed according to the contract documents, and operate within the performance guidelines set out in the design intent documents (D.I.D.) and these specifications. The CA will provide the owner with an unbiased, objective view of the system's installation, operation, and performance. The commissioning process does not take away or reduce the responsibility of the installing contractors to provide a finished product, installed and fully functional in accordance with the contract documents.
- B. Commissioning is intended to enhance the quality of system start-up and aid in the orderly completion and transfer of systems for beneficial use by the owner. The CA will be the leader of the commissioning team, planning and coordinating all commissioning activities in conjunction with the design professionals, construction manager, subcontractors, manufacturers and equipment suppliers.
- C. The General Contractor, Plumbing Contractor, Mechanical Contractor, all Division 23 sub-contractors, Electrical Contractor and all Division 26 sub-contractors shall be responsible for cooperating, and coordinating their work, with the CA. They shall also be responsible for carrying out all the physical activities required for installation of components and systems, and operating them during the commissioning process as required in this Section.

##### 1.04 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions, general mechanical provisions and applicable Divisions 22, 23, 26 and 32 Specification sections, apply to work of this section.

##### 1.05 REFERENCES

- A. ASHRAE Guideline 0 - 2019

#### **PART 2 – PRODUCTS**

##### 2.01 PLUMBING, HVAC, ELECTRICAL AND IRRIGATION SYSTEMS TO BE COMMISSIONED

- A. The systems installed under this contract are to be inspected, tested, signed off as complete and operational, and operated for commissioning agency verification as described in Part 3 of this Section. This includes, but is not necessarily limited to the work listed for each system.

The foregoing includes all the following:

1. Domestic hot water systems - work includes installation inspections and checks; confirmation of flow balancing completion; leak testing as applicable.
2. Duct and air-handling systems – work includes installation inspections and checks; confirmation of flow balancing completion; leak testing as applicable.
3. Supply, Return, Relief and Exhaust Fans – Work includes checks on installation (including dampers and other accessories), rotation, motor current draw, and airflows and pressures.
4. Chilled water piping systems – work includes installation inspections and checks; pressure tests and documentation of the chiller, pumps and associated piping.
5. Hot water water piping systems – work includes installation inspections and checks; pressure tests and documentation of the boiler, pumps and associated piping.
6. Direct digital controls system – Work includes inspections and checks of installation and operation of all devices; complete operation of all controls sequences, in coordination with commissioning of all controlled systems.
7. Lighting control systems – Work includes inspections and checks of installation and operation of all devices, complete operation of all controls sequences, in coordination with commissioning of all controlled systems.
8. Emergency power systems - Work includes inspections and checks of installation and operation of all devices (generator, ATS, fuel tank, and other supporting equipment), complete operation of all controls sequences, in coordination with commissioning of all controlled systems.
9. Solar photovoltaic (PV) systems - work includes installation inspections and checks; complete operation of all equipment.
10. Irrigation systems - work includes installation inspections and checks; complete operation of all controls sequences.
11. The contractor shall be responsible for carrying out all work required for commissioning these systems that is defined as a contractor responsibility in Part 3 of this Section.

## 2.02 SYSTEM VERIFICATION CHECKLISTS

- A. The systems verification checklists shall be generated by the CA and provided to the GC during the commissioning construction kickoff meeting.

## 2.03 FUNCTIONAL PERFORMANCE TEST CHECKLISTS

- A. The CA shall provide functional performance test checklists as listed below 6 weeks prior to substantial completion:
  1. Domestic hot water system
  2. Air handling unit systems, including medium air distribution
  3. Chilled water plant including pipe distribution
  4. Heating hot water plant including pipe distribution
  5. Variable air volume (VAV) boxes including low pressure air distribution
  6. Exhaust system
  7. Lighting controls systems, including occupancy sensors, photocells, and time clocks.

8. Emergency power generator system
9. Solar photovoltaic (PV) system

2.04 MEMBERS OF THE COMMISSIONING TEAM

A. The commissioning team will consist of representatives of the following:

1. owner
2. end user
3. architect
4. mechanical design engineer (ME)
5. electrical design engineer (EE)
6. commissioning agency (CA)
7. general contractor (GC)
8. plumbing (Div. 22) contractor (PC)
9. mechanical (Div. 23) contractor (MC)
10. electrical (Div. 26) contractor (EC)
11. controls contractor (ATC)
12. testing, adjusting, and balancing agency (TAB)
13. lighting controls contractor (LCC)
14. irrigation contractor (IC)
15. owner's O&M staff

B. During the commissioning process, participation of team members will generally be required as noted in the following table (with abbreviations as noted in brackets in the preceding list of team members). The mechanical contractor, indicated by "MC", includes all mechanical subcontractors or suppliers whose participation is required for commissioning a particular system or piece of equipment. The electrical contractor, indicated by "EC", includes all electrical subcontractors or suppliers whose participation is required for commissioning a particular system or piece of equipment. Should the PC or IC have subcontractors that are necessary for the commissioning activities under their responsibility, they shall provide support to complete the commissioning of the respective equipment or systems.

EQUIPMENT/SYSTEM DESCRIPTION	TEAM MEMBERS							
	CA	PC	MC	TAB	ATC	EC	LCC	IC
DHW	X	X	X	X	X	X		
AHU	X		X	X	X	X		
Chiller	X		X	X	X	X		
Boiler	X		X	X	X	X		
VAV boxes	X		X	X	X	X		
Exhaust fan	X		X	X	X	X		
Lighting controls	X				X	X	X	
Emergency power	X				X	X		
Solar photovoltaic (PV) system	X				X	X		
Irrigation	X							X



## **PART 3 – EXECUTION**

### **3.01 COMMISSIONING RESPONSIBILITIES – NON-CONTRACTOR TEAM MEMBERS**

#### **A. Introduction**

- B. As noted in 2.2, a multi-disciplinary team carries out commissioning. The commissioning responsibilities of some non-contractor team members during the construction and acceptance phases of the project are provided here for information, and to provide some context for the overall process.

#### **C. Commissioning Agency Responsibilities**

The commissioning agency will:

1. plan, organize and implement the commissioning process as specified herein,
2. prepare the commissioning plan, and ensure its distribution for review and comment,
3. revise the commissioning plan as required during construction,
4. chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting,
5. in conjunction with the General Contractor, coordinate commissioning activities among all contractors, sub-trades and suppliers,
6. monitor system verification checks, and ensure the results are documented as the checks are done,
7. monitor controls point-to-point checks done by the controls contractor, and ensure the results documented as the checks are done,
8. observe all start-ups and initial system operations tests and checks,
9. direct the contractors to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes,
10. witness all functional performance tests and document the results,
11. prepare and submit a Commissioning Report which documents all checks and tests done throughout the Commissioning process, and the results obtained from each, and
12. Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated operating staff.

#### **D. Mechanical Engineer Responsibilities**

1. During the acceptance phase of the commissioning process, the Mechanical Engineer may, at their discretion, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance.

#### **E. Electrical Engineer Responsibilities**

1. During the acceptance phase of the commissioning process, the Electrical Engineer may, at their discretion, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance.

#### **F. Owner's Responsibilities**

1. The Owner will ensure the availability of operating staff for all scheduled instruction and demonstration sessions. This staff will possess sufficient skills and knowledge to operate and maintain the installation following attendance at these sessions.

### 3.02 COMMISSIONING RESPONSIBILITIES – GENERAL CONTRACTOR

- A. The General Contractor has responsibility to ensure the overall completion of the Work. In this regard, he shall:
1. participate as required in the HVAC commissioning process,
  2. ensure the Plumbing Contractor performs all assigned plumbing commissioning responsibilities as specified in 3.03,
  3. ensure the Mechanical Contractor performs all assigned HVAC and electrical commissioning responsibilities as specified in 3.04,
  4. ensure the Electrical Contractor performs all assigned HVAC and electrical commissioning responsibilities as specified in 3.07,
  5. ensure the Irrigation/Landscape Contractor performs all assigned irrigation commissioning responsibilities as specified in 3.08,
  6. ensure the cooperation and participation in the HVAC and electrical commissioning process of all other sub-contractors as applicable.
- B. The General Contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the general contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall facilitate communications among all contractors and suppliers and other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. In the event that any scheduled equipment or system start-ups or functional performance tests are terminated because the CA, mechanical engineer or the electrical engineer discover deficient or incomplete work, or due to the non-attendance of required contractor or supplier personnel, the contractor or sub-contractor responsible for the termination shall also be responsible for paying reasonable costs of time and travel expenses of any or all of the following representatives who were physically present for the purpose of witnessing the start-up or the FPT: the CA, the mechanical engineer, the electrical engineer, and the owner. The owner may provide a statement to the General Contractor identifying the specific activity that was terminated, the scheduled date, and a list of those in attendance, along with their reasonable time and travel expense costs.

### 3.03 COMMISSIONING RESPONSIBILITIES – DIVISION 22 (PLUMBING) CONTRACTOR

- A. The plumbing contractor, and all the sub-contractors and suppliers within Division 22, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.
- B. The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of plumbing commissioning. The representative shall ensure communications between Division 22 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. The Plumbing Contractor, and all plumbing sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the commissioning process. In this context, the Plumbing Contractor shall:

1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
2. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
3. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
4. Attend plumbing commissioning meetings scheduled by the CA.
5. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system start-ups.
6. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
7. Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.
8. Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section.
9. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the CA to witness formal functional performance tests (FPTs).
10. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
11. Prepare preliminary schedule for plumbing system orientation and inspections. O & M manual submission, training sessions, pipe testing, flushing and cleaning, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
12. Attend initial O&M staff training session.
13. Conduct plumbing system orientation and inspection at the equipment placement completion stage.
14. Update drawings to as-built condition.
15. Provide a complete set of as-built drawings and O & M manuals to the CA.

#### **3.04 COMMISSIONING RESPONSIBILITIES – DIVISION 23 (MECHANICAL) CONTRACTOR**

- A. The mechanical contractor, and all the sub-contractors and suppliers within Division 23, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.

- B. The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall ensure communications between Division 23 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. The Mechanical Contractor, and all mechanical sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the HVAC commissioning process. In this context, the Mechanical Contractor shall:
1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
  2. Ensure the automatic temperature controls (ATC) contractor performs HVAC commissioning responsibilities as listed in 3.06.
  3. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.
  4. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
  5. Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, and refrigeration as applicable.
  6. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
  7. Attend HVAC commissioning meetings scheduled by the CA.
  8. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system start-ups.
  9. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
  10. Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.
  11. Notify the CA a minimum of two weeks in advance, of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
  12. Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section.
  13. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the CA to witness formal functional performance tests (FPTs).

14. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
15. Prepare preliminary schedule for mechanical system orientation and inspections. O & M manual submission, training sessions, duct system testing, flushing and cleaning, equipment start-up TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
16. Attend initial O&M staff training session.
17. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
18. Update drawings to as-built condition.
19. Provide written notification to the general contractor and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.
  - a. HVAC equipment including all fans, air handling units, chillers and associated pumps, boilers and associated pumps, variable air volume boxes, ductwork, dampers, fan coil units and all Division 23 equipment.
  - b. That the building control system is functioning to control mechanical equipment control systems as specified.
20. Provide a complete set of as-built drawings and O & M manuals to the CA.

### 3.05 COMMISSIONING RESPONSIBILITIES – TAB AGENCY

#### A. With respect to HVAC commissioning, the TAB agency shall:

1. Include costs for HVAC commissioning requirements in the quoted price.
2. Attend commissioning meetings scheduled by the CA prior to, and during, on-site TAB work being done.
3. Submit proposed TAB procedures to the CA and mechanical engineer for review and acceptance.
4. Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the HVAC system.
5. At the completion of the TAB work, submit the final TAB report to the general contractor with copies to the Owner, CA and mechanical engineer.
6. Participate in verification of the TAB report by the CA for verification or diagnostic purposes. This will consist of repeating a sample (10%) of the measurements contained in the TAB report as directed by the CA.
7. Participate in O & M personnel training sessions as scheduled by the CA.

### 3.06 COMMISSIONING RESPONSIBILITIES – CONTROLS CONTRACTOR

#### A. With respect to HVAC commissioning, the controls contractor shall:

1. Include cost for commissioning requirements in the quoted price.
2. Review design for controllability with respect to equipment selected for the project;

- a. Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.
  - b. Review and confirm in writing that proper safeties and interlocks are included in design.
  - c. Ensure the proper selection of sensor ranges and include data with submittal to mechanical engineer.
  - d. Clarify all questions concerning sequences of operation with the mechanical engineer.
3. Attend commissioning meetings scheduled by the CA.
4. Provide the following submittals to the CA for review;
  - a. Hardware and software submittals.
  - b. Diagrams showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.
  - c. Narrative description of all control sequences for each piece of equipment controlled.
  - d. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
  - e. Hardware operation and maintenance manuals.
  - f. Application software and project applications code manuals.
5. Inspect, check, and confirm the proper installation and performance of controls/BAS hardware and software provided by others.
6. Integrate installation and programming scheduling with construction and commissioning schedules.
7. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
8. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.
9. In conjunction with the mechanical contractor, demonstrate system performance to the CA including all modes of system operation (e.g. occupied, unoccupied, emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section.
10. Provide control system technician to assist during system verification and functional performance testing.
11. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and commissioning agencies, all devices and all software for the TAB agency to use in completing TAB procedures.

### 3.07 COMMISSIONING RESPONSIBILITIES – ELECTRICAL (DIVISION 26) CONTRACTOR

- A. The Electrical Contractor, and all electrical/lighting sub-contractors and suppliers, shall cooperate with the CA in carrying out the electrical commissioning process. In this context, the Electrical Contractor shall:
  1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
  2. Ensure the lighting controls (LCC) contractor performs electrical commissioning

responsibilities as listed in 3.07.

3. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and electrical engineer, and with the participation of qualified technicians from major equipment suppliers and the lighting controls contractor.
4. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
5. Ensure cooperation and participation of specialty sub-contractors.
6. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
7. Attend electrical commissioning meetings scheduled by the CA.
8. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system start-ups.
9. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
10. Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.
11. Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section.
12. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the CA to witness formal functional performance tests (FPTs).
13. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the lighting controls contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
14. Prepare preliminary schedule for electrical system orientation and inspections. O & M manual submission, training sessions, equipment start-up, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
15. Attend initial O&M staff training session.
16. Conduct electrical system orientation and inspection at the equipment placement completion stage.
17. Update drawings to as-built condition.
18. Provide written notification to the general contractor and CA that the following work

has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.

- g. Electrical equipment including all Division 22, 23 and 26 equipment.
- h. That the building control system is functioning to control lighting equipment as specified.
- i. The emergency power system is functioning as specified
- j. The solar photovoltaic (PV) system is functioning as specified

19. Provide a complete set of as-built drawings and O & M manuals to the CA.

B. With respect to HVAC commissioning, the electrical contractor shall:

- 1. Include cost for HVAC commissioning requirements in the quoted price.
- 2. Review design with respect to providing power to the HVAC equipment;
  - a. Verify that proper hardware specifications exist for functional performance and sequence of operation required by specification.
  - b. Verify that proper safeties and interlocks are included in the design of electrical connections for HVAC equipment.
- 3. Attend commissioning meetings scheduled by the CA.
- 4. Schedule work so that required electrical installations are completed, and systems verification checks and functional performance tests can be carried out on schedule.
- 5. Inspect, check and confirm in writing the proper installation and performance of all electrical services provided.
- 6. Provide electrical system technicians to assist during system verification and functional performance testing as required by the CA.

### 3.08 COMMISSIONING RESPONSIBILITIES – LIGHTING CONTROLS CONTRACTOR

A. With respect to lighting controls commissioning, the controls contractor shall:

- 1. Include cost for commissioning requirements in the quoted price.
- 2. Review design for controllability with respect to equipment selected for the project;
  - a. Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.
  - b. Ensure the proper location and use of occupancy sensors, photocells and other lighting control components are specified and installed. Include in the lighting controls submittal the types of occupancy sensors, technology used for occupancy sensing in each unique zone, types of photocells and technology used of photocells.
  - c. Clarify all questions concerning sequences of operation with the electrical engineer.
- 3. Attend commissioning meetings scheduled by the CA.
- 4. Provide the following submittals to the CA for review;
  - a. Hardware and software submittals.
  - b. Diagrams showing all control points, sensor locations, point names, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.
  - c. Narrative description of all control sequences for each piece of equipment controlled.
  - d. Provide a separate list for each stand-alone control unit.
  - e. Hardware operation and maintenance manuals.
  - f. Application software and project applications code manuals.

12. Inspect, check, and confirm the proper installation and performance of lighting



controls hardware and software provided by others.

13. Integrate installation and programming scheduling with construction and commissioning schedules.
14. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
15. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.
16. In conjunction with the electrical contractor, demonstrate system performance to the CA including all modes of system operation (e.g. occupied, unoccupied, emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section.
17. Provide control system technician to assist during system verification and functional performance testing.

### 3.03 COMMISSIONING RESPONSIBILITIES – DIVISION 32 (IRRIGATION) CONTRACTOR

- A. The irrigation contractor, and all the sub-contractors and suppliers within Division 32, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.
- B. The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of irrigation commissioning. The representative shall ensure communications between Division 32 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. The Irrigation Contractor, and all irrigation sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the commissioning process. In this context, the Irrigation Contractor shall:
  1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
  2. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
  3. Attend irrigation commissioning meetings scheduled by the CA.
  4. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system start-ups.
  5. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
  6. Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.

7. Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section.
8. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the CA to witness formal functional performance tests (FPTs).
9. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.02 in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
10. Prepare preliminary schedule for irrigation system orientation and inspections. O & M manual submission, training sessions, pipe testing, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
11. Update drawings to as-built condition.
12. Provide a complete set of as-built drawings and O & M manuals to the CA.

**END OF SECTION**

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## SECTION 01 99 99

### FORMS

#### **PART 1 – GENERAL**

##### 1.01 SECTION INCLUDES

- A. Certificate of Stored Materials
- B. Change Order Request (COR) for Subcontractors
- C. Guarantee Form
- D. Submittal Cover Sheet
- E. Systems Shutdown / Off Hour Work Request
- F. Testing & Inspection Request
- G. Time & Material Daily Report - for Added Work
- H. Closeout Document For (Cover Sheet)

#### **PART 2 – PRODUCTS**

NOT USED

#### **PART 3 – EXECUTION**

##### 3.01 Certificate of Stored Materials

- A. This form must be notarized, executed and submitted with Application for Payment when Contractor is billing for stored materials.

##### 3.03 Change Order Request (COR) for Subcontractors

- A. All COR's must be submitted on this form. No other form will be accepted.

##### 3.04 Guarantee Form

- A. This form must be submitted with the final payment application and provides the Contractor's guarantee that the Work was completed as specified and will remain so.

##### 3.06 Submittal Cover Sheet

- A. All submittals shall be submitted on this form. No other form will be accepted. Submittals will be returned to Contractor for compliance.

##### 3.08 System Shutdown/Off Hour Work Request

- A. This form is used to request Systems Shutdown / After Hours Work. One (1) week notice required.

##### 3.09 Testing & Inspection Request

- A. This form must be submitted to the Inspector of Record at least forty-eight (48) hours in advance of any necessary Testing and Inspection on the project.

##### 3.10 Time & Material Daily Report – For Added Work

- A. Complete this Form each day for work assigned to a Field Work Directive. All labor, equipment and materials must be identified daily to be considered for a Change Event.

##### 3.11 Closeout Documents Form (Cover Sheet)

- A. Contactor must use/submit this form with their closeout package

**END OF SECTION**

NOT FOR BID

## Certificate of Stored Materials

To: County of San Bernardino

The below listed materials, supplies and equipment (hereinafter defined as material) are stored at

Address

and can be inspected upon reasonable notification:

Stored Material Item - Description	Stored Location	Quantity	Invoice Value *

\*Invoice copy attached (Attach additional sheets as needed.)

Contractor's Material Cost.....\$

Total Cost (Invoice Value Plus Handling Cost).....\$

Upon receipt of payment (payment defined as invoiced cost plus material handling cost without overhead and profit) as petitioned by Contractor's Application For Payment No. \_\_\_\_\_ Item(s) \_\_\_\_\_, dated \_\_\_\_\_, the undersigned hereby certifies the following:

1. Full, clear and unencumbered title and ownership of the material is transferred, assigned and vested to County.
2. The material is to be held in trust for the benefit of County and for the exclusive use of County until such time as the materials are incorporated into the work. The Contractor reaffirms his continued obligation to store and protect the material until completion of the work. All cost related to the procuring, transporting, insuring and improving, repairing or leasing facilities for storage of material is the sole cost of the Contractor.
3. A current Certificate of Insurance coverage is attached or presently on file with County.
4. The Certificate of Stored Materials shall constitute a Bill of Sale if accompanied by proof of payment for the referenced materials.

As evidence and surety of this obligation and for the protection of County, the Contractor (see County Contract) will provide and maintain an "ALL RISKS" insurance policy for the invoice value of material. Further, the Contractor agrees to be responsible and accountable for any and all damage to or destruction of the material, insurance coverage notwithstanding.

**Contractor:**

Sworn to and subscribed before me this

\_\_\_\_\_ day of \_\_\_\_\_, \_\_\_\_\_  
Day Month Year

\_\_\_\_\_  
Notary Public

My commission expires: \_\_\_\_\_

\_\_\_\_\_  
Company Name

By: \_\_\_\_\_  
Authorized Signature

Title: \_\_\_\_\_

Date: \_\_\_\_\_

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**NOT FOR  
SAMPLE  
BID**

## Change Order Request (COR) for Subcontractors

**Project:** ISD Acquisitions & Improvements

**Date:** \_\_\_\_\_

**Reference:** IB #: \_\_\_\_\_ FWD #: \_\_\_\_\_ RFI #: \_\_\_\_\_

**Description of Work:**

**Contractor:** \_\_\_\_\_ **Contractor's Reference #:** \_\_\_\_\_

1. Material Cost (attach backup)	_____
2. Sales Tax _____ %	_____
3. Freight and Delivery Expense (Attach Backup)	_____
<b>Material/Equipment/Tools Subtotal:</b>	_____
4. Direct Labor (attach backup)	
Classification _____	
Man Hours @ \$ _____	_____
5. Overtime (attach backup)	_____
6. Payroll Taxes and Insurance (Liability & Property Damage Insurance, Worker's Comp., Social Security, And Unemployment Taxes) – (attach backup)	_____
Refer to labor wage break down form	
<b>Labor Subtotal:</b>	_____
<b>Miscellaneous Subtotal:</b>	_____

**CHANGE REQUEST SUBTOTAL:**

Mark-up (10% max): \_\_\_\_\_

**CHANGE REQUEST SUBTOTAL:** \_\_\_\_\_

**Note:** Price Firm for \_\_\_\_\_ days

A Contract Time Extension of \_\_\_\_\_ days is requested (attach schedule analysis)

**Prepared by:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Approval:** \_\_\_\_\_ **Date:** \_\_\_\_\_



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NOT FOR BID

## County of San Bernardino

### GUARANTEE FORM

\_\_\_\_\_ (Contractor's Name) hereby unconditionally guarantees that the work performed for the **ISD Acquisitions & Improvements** has been done in accordance with the requirements of the Contract and therefore further guarantees the work of the contract to be and remain free of defects in workmanship and materials for a period of one (1) year from the date of completion of the contract, unless a longer guarantee period is called for by the Contract Documents, in which case the terms of the longer guarantee shall govern. The Contractor hereby agrees to repair or replace any and all work, together with any other work which may have been damaged or displaced in so doing, that may prove to be not in accordance with the requirements of the Contract or that may be defective in its workmanship or materials within the guarantee period specified, without any expense whatsoever to the County, ordinary wear and tear and unusual abuse and neglect only excepted. The Contractor has provided contract bonds which will remain in full force and effect during the guarantee period.

The Contractor further agrees that within ten (10) calendar days after being notified in writing by the County of any work not in accordance with the requirements of the contract or any defects in the work, he will commence and prosecute with due diligence all work necessary to fulfill the terms of this guarantee, and to complete the work within a reasonable period of time. In the event he fails to so comply, he does hereby authorize the County to proceed to have such work done at the Contractor's expense and he will pay the cost thereof upon demand. The County shall be entitled to all costs, including reasonable attorneys' fees, necessarily incurred upon the Contractor's refusal to pay the above costs.

Notwithstanding the foregoing paragraph, in the event of an emergency constituting an immediate hazard to the health or safety of the employees of the County, or its property or licensees, the County may undertake at the Contractor's expense without prior notice, all work necessary to correct such hazardous condition when it was caused by the work of the Contractor not being in accordance with the requirements of this contract, or being defective, and to charge the same to the Contractor as specified in the preceding paragraph.

The guarantee set forth herein is not intended by the parties, nor shall it be construed, as in any way limiting or reducing the County's rights to enforce all terms of the contract referenced hereinabove or the time for enforcement thereof. This guarantee is provided in addition to, and not in lieu of, the County's rights on such contract.

\_\_\_\_\_  
CONTRACTOR'S SIGNATURE

Representative to be contacted for services:

Name: \_\_\_\_\_

Address: \_\_\_\_\_  
\_\_\_\_\_

Office No.: \_\_\_\_\_

Mobile No.: \_\_\_\_\_

Fax No.: \_\_\_\_\_

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**NOT FOR  
SAMPLE  
BID**

**COUNTY OF SAN  
BERNARDINO  
SUBMITTAL COVER SHEET**

**PROJECT NAME:** ISD Acquisitions and Improvements

**Contractor:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Product Manufacturer:** \_\_\_\_\_

**Specification Section:** \_\_\_\_\_

Sub Section No: _____	Section Description: Product Data
Sub Section No: _____	Section Description: Samples
Sub Section No: _____	Section Description: _____
Sub Section No: _____	Section Description: _____
Sub Section No: _____	Section Description: _____

\* Submittal item noted as required and is forthcoming

**CHECK ONE OF THE FOLLOWING:**

Specified Material (7 copies + as required by Contractor)  
Proposed Equal (Attach Substitution Request Form )

**CONTRACTOR'S REVIEW**

The Contractor has reviewed and approved the field dimensions and construction criteria of the attached submittal. The Contractor has verified that the submittal includes notations of any portion of the work depicted in the submittal which is not in strict conformity with the contract documents. The information in the attached submittal has been reviewed and coordinated by the Contractor with information included in other submittals.

**REVIEWED AND SUBMITTED BY:** \_\_\_\_\_

(Signature)

(Date)

**OWNER'S REPRESENTATIVE REVIEW**

Reviewed By _____	Date _____
Project Name _____	
TCC Submittal No. _____	
Reviewed for Completeness	
Incomplete Submittal	
Not Reviewed	
Comments _____	

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**NOT FOR BID**

**County of San Bernardino**  
**ISD Acquisitions & Improvements**  
**Systems Shutdown / Off Hour Work Request**

**Contractor Name:** \_\_\_\_\_

**Bid Category No./Name:** \_\_\_\_\_

**Instructions:**

Complete this form one (1) week prior to the planned operation. Approved by the Company indicated above and the County or County's representative must be received **PRIOR** to executing the requested event. The approval of this request does not in any way authorize or approve additional project costs associated with these activities. This Form is used to assist in planning, scheduling and coordinating construction activities required by the project located on the County site without disruption to normal County activities.

**Date Submitted:** \_\_\_\_\_ **Requested Start Date / Time :** \_\_\_\_\_ **End Date / Time:** \_\_\_\_\_  
**Estimated Duration:** \_\_\_\_\_ **Hours**

**This Request is for:** Site Utility Shutdown ☐ Active Site Utilities Shut Down ☐ Off Hours Work ☐

**Utility status during activity:** Active ☐ Inactivate ☐ **Construction Trades Involved:** \_\_\_\_\_

**OSHA and Site Safety** requirements discussed, reviewed and acknowledged to be in place: Yes ☐ No ☐

**Event Description in Detail**

Scope of Work	
Supervision Requirements	
Location of Work	
Utility / Systems Impacted	
Work to Complete prior to shutdown activities	
Special Materials or Equipment	
Impacted Trades	

Submitted by \_\_\_\_\_ Title: \_\_\_\_\_ Contractor: \_\_\_\_\_

Additional Information Attached: Yes ☐ No ☐

**Approvals:**

County of San Bernardino: By: \_\_\_\_\_ Title \_\_\_\_\_ Date: \_\_\_\_\_

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EXAMPLE  
BID**

# TESTING AND INSPECTION REQUEST

TO BE SUBMITTED 24 HOURS IN ADVANCE

Request No. \_\_\_\_\_

Date of Issuance: \_\_\_\_\_

County of San Bernardino

Contractor: \_\_\_\_\_

Inspection Required By: \_\_\_\_\_  
(DATE AND TIME)

P. O. No.: \_\_\_\_\_

Inspection Required By: \_\_\_\_\_  
(LAB, DSA INSPECTOR, OTHER)

Contract For: \_\_\_\_\_

Engineer / Architect: \_\_\_\_\_

We are hereby requesting the following Test and / or Inspection:

Description of Test / Inspection required:

\_\_\_\_\_

Method of Testing and Inspection Performed:

Testing and Inspection Performed by:

☐ Testing and Inspection Laboratory

☐ DSA Inspector

☐ Project Superintendent

☐ Other

Results of Tests / Inspection:

Attachments / supporting documents:

\_\_\_\_\_

☐ Contractor is hereby released to proceed with work in area(s) indicated above

☐ Contractor is hereby ordered to correct work as described above before proceeding with work in areas(s) indicated above

☐ Other: \_\_\_\_\_

\_\_\_\_\_

Date: \_\_\_\_\_



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**NOT FOR  
EXAMPLE  
FOR  
BID**

## Time & Materials Daily Reports - For Added Work

### County of San Bernardino

#### ISD Acquisitions & Improvements

**Contractor Name:** \_\_\_\_\_

**Bid Category No./Name:** \_\_\_\_\_

#### Instructions:

Complete this form each day for work (Time and Materials) assigned to a Field Work Directive (FWD). All labor, equipment and materials must be identified daily to be considered for a Change Event. This Form must be signed by the designated General Contractor Representative or Inspector of Record, each day, to be a valid representation of work performed on this day and associated with the issued FWD.

**Contractor:** \_\_\_\_\_ **Date Submitted:** \_\_\_\_\_

**Issued FWD #** \_\_\_\_\_

#### Brief Description of Work Performed Today:


#### Labor

Total Men	List by Trade	Man Hours	Work Area Designation / Location

#### Equipment

Type	Description	Hours Used

## Materials

[illegible]

Remarks:

Additional Information Attached: Yes ☐ No ☐

**Approvals:**

**General Contractor:** By: \_\_\_\_\_ Title \_\_\_\_\_

Date: \_\_\_\_\_

**Inspector of Record:** By: \_\_\_\_\_ Title \_\_\_\_\_

Date: \_\_\_\_\_

# ISD Acquisitions & Improvements COUNTY OF SAN BERNARDINO

## CLOSEOUT DOCUMENTS FOR:

SPECIFICATION SECTION(S): \_\_\_\_\_

DATE: \_\_\_\_\_

- Bid Category Contractor #: \_\_\_\_\_
- Submitted By: \_\_\_\_\_

Prepared by: \_\_\_\_\_

Verified for Completeness by: \_\_\_\_\_

Signature/Date: \_\_\_\_\_

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NOT FOR BID

## SECTION 02 41 19

### SELECTIVE DEMOLITION

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Furnish all labor and equipment necessary to perform demolition and site clearing work as shown on drawings and specified herein, including removal of slabs, curbs, walls, partitions, fixtures, finishes, and other items as indicated and required for new construction.
- B. Protect all existing installations from damage. Take measures to prevent damage to existing facilities and finishes during demolition and construction.
- C. Carefully remove items which are to remain property of Owner, and store in secure, dry area for later reuse.
- D. Salvaged Material (not wanted by Owner): Items which the Owner does not want and is of salvable value to Contractor may be removed from structure as work progresses. Owner and CBC 2016 require a minimum of 50% (by weight) of all non-hazardous construction materials be recycled, composted and/or salvaged.
- E. Related Work Specified elsewhere:
  - 1. Disconnecting and capping existing gas, water, sewer and electrical utilities is included under other Divisions. Coordinate with work under these Divisions to make sure their work is complete before starting demolition work affecting these utilities.
  - 2. Removal of Plumbing: Division 22.
  - 3. Removal of Mechanical: Division 23.
  - 4. Removal of Electrical: Division 26.

##### 1.03 STANDARDS AND REFERENCES

###### A. Definitions:

- 1. Except for items or materials indicated to be reused, salvaged or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition by the Contractor(s) in a legal disposal area appropriate to the materials being disposed
- 2. "Remove": Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.
- 3. "Removed and salvaged": Items to remain the Owner's property shall be removed, cleaned, and packed or crated to protect against damage. Identify contents and deliver to Owner's designated storage area.
- 4. "Existing to Remain" Protect construction indicated to remain against damage and soiling during demolition. When permitted by the Architect, items may be removed to a suitable, protected storage location during demolition and then cleaned and reinstalled in their original locations.
- 5. "Remove and Reinstall": Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in locations indicated.

- B. Codes and Regulations: Demolition work shall comply with local ordinances and Safety Codes of State of California and rules and regulations of Industrial Accident Commission of State of California' applicable to demolition work.

#### 1.04 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Engage an experienced firm that has successfully completed demolition work similar to that indicated for this Project.
- B. Safety Precautions: Perform demolition work in such a manner as to prevent damage to existing facilities to remain or to be salvaged, and to prevent injury to public and workmen engaged on site under this or other contracts.

#### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00.

#### 1.06 SUBMITTALS

- A. Submit each item in this Article Submit according to the requirements of Section 01 33 00.
- B. Proposed Dust Control Measures.
- C. Proposed Noise Control Measures.
- D. Schedule of demolition activities indicating the following:
  - 1. Detailed sequence of demolition, salvage, and removal work, with starting and ending dates for each activity.
  - 2. Dates for shutoff, capping, and continuation of utility services.
- E. Salvage Plan - Inventory of items to be removed and salvaged. Salvage plan shall show how all materials are to be sorted, salvaged and recycled. Plan must include all final destinations for each type of material.
  - 1. Contractor shall submit salvage plan showing how all materials are to be sorted, salvaged and recycled. Plan must include all final destinations for each type of material.
  - 2. Salvaged items must be transported from site as they are removed, unless materials are to be reused on site.
  - 3. Storage or sale of removed items on site will not be permitted, unless materials are to be reused on site.
  - 4. Contractor shall provide certification for all salvaged materials. Certifications may take the form of receipts from recycling facilities, manufacturers, or any other legitimate form of certification. Certification types shall be outlined in salvage plan and approved by Owner.
- F. Inventory of items to be removed and salvaged, and deliver to Owner's designated storage area.
- G. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and improvements that might be misconstrued as damage caused by demolition operations.
- H. Pre-Demolition Conference: Conduct conference at Project site with Owner, Architect and Construction Manager

## **PART 2 - PRODUCTS**

NOT APPLICABLE

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Confirm existing conditions and correlate with requirements indicated to determine extent of demolition required.
- C. Inventory and record the conditions of items to be removed and reinstalled and items to be removed and salvaged.
- D. Correct conditions detrimental to timely and proper completion of the Work.
- E. Do not proceed until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of conditions.
- G. Confirm condition of the building to determine whether removing any element might result in a structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during demolition.
- H. Perform surveys as the Work progresses to detect hazards resulting from demolition activities.

### **3.02 PREPARATION**

- A. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
- B. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- C. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around demolition area.
  - 1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways.
  - 2. Protect existing site improvements, appurtenances, and landscaping to remain.
- D. Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of building to remain.
- E. Strengthen or add new supports when required during progress of demolition.

### **3.03 SCHEDULING**

- A. Protect all existing installations from damage. Take measures to prevent damage to existing facilities and finishes during demolition and construction.
- B. Arrange demolition and salvage schedule so as not to interfere with Owner's on-site operations.

### **3.04 ITEMS REMOVED BY CONTRACTOR AND RETAINED BY OWNER**

General: Items noted on drawings shall be removed without damage and turned over to Owner. Coordinate with Owner and arrange for designated storage area.

### **3.05 UTILITY SERVICES**

- A. Utility Requirements: Refer to Division 21 through Division 26 sections for shutting-off, disconnecting, removing, and sealing or capping utility services. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.
- B. Maintain existing utilities indicated to remain in service and protect them against damage



during demolition operations.

- C. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner, and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.
- D. Provide not less than 72 hours notice to Owner if shutdown of service is required during changeover.

### 3.06 EXPLOSIVES

The use of explosives will not be permitted.

### 3.07 POLLUTION CONTROLS

- A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.
- B. Do not create hazardous or objectionable conditions, such as flooding, and pollution, when using water.
- C. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- D. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.
- E. Clean adjacent buildings and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before start of demolition.

### 3.08 DEMOLITION

- A. Demolish concrete and/or asphalt paving, and densified granite surfaces, as required to prepare for new construction.
- B. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.
- C. Fill below-grade areas and voids resulting from demolition of building elements and pavements and soil materials according to requirements of Division 31.
- D. Promptly repair damages to adjacent facilities caused by demolition operations.
- E. Wherever cutting and removal of portions of existing work is indicated, such work shall be sawn in a manner that will produce neat and straight lines, parallel to adjacent surfaces or plumb for vertical surfaces. Execute cutting and demolition by methods which will prevent damage to other work, and which will provide proper surfaces to receive installation of repairs and new work.

### 3.09 DISPOSAL OF DEMOLISHED MATERIALS

- A. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Removal: All materials resulting from demolition work, except those items specifically listed to be retained by Owner, shall become property of contractor and shall be removed from premises. All material to be removed needs to be out of the area as scheduled.
  - 1. Establish haul routes in advance and post flagmen to assure safety of public and workmen.
  - 2. Keep streets (and facilities) free of mud, rubbish, etc. Assume responsibility for any damage resulting from hauling operations and hold Owner free and clear of any liability in connection therewith.

- C. Burning demolished materials is not allowed.
- D. Transport demolished materials off Owner's property and legally dispose of these materials.

**END OF SECTION**

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SECTION 03 10 00  
CONCRETE FORMWORK AND ACCESSORIES

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Requirements of Division 1 apply to all work of this section.

1.02 SCOPE

- A. Design, furnish and install forms for concrete as indicated on drawings and specified here. Remove forms and shores at specified time. Clean up.

1.03 RELATED WORK (See also Table of Contents)

- A. Reinforcing Steel: Section 03 21 00.  
B. Cast-In-Place Concrete: Section 03 30 00.  
C. Structural Steel: Section 05 12 00.  
D. Metal Fabrications: Section 05 50 00.  
E. Rough Carpentry: Section 06 10 00.  
F. Items relating solely to mechanical or electrical work are included under those Divisions, except as specifically indicated otherwise on Drawings.

1.04 QUALITY ASSURANCE

- A. General:
1. Conform to all requirements of ACI 347 and ACI 318 Section 26.11.
  2. Concrete formwork shall be designed and constructed to safely support fluid concrete and superimposed construction loads without excessive deflection or concrete leakage. Provide bracing to maintain accurate alignment and to resist all anticipated lateral loads. Forms shall conform with drawings as to shape, line, and dimension. Design, engineering and construction of forms shall be Contractor's responsibility. Formwork for exposed concrete shall be constructed to tolerances indicated in ACI 303R.
  3. Cooperate and coordinate with other trades who furnish and/or install piping, conduit, reglets, anchors, inserts, sleeves, hangers, etc., as their work requires; including provisions for recesses and chases.
- B. Submittals: (Submit under provisions of Section 01 33 00)
1. Product Data. Provide manufacturers data and installation instructions for the following:
    - a. Tie rods and spreaders.
    - b. Formwork for exposed concrete.
    - c. Form coatings and release agents.
- C. Standards and References: (Latest Edition unless otherwise noted)
1. 2019 California Building Code (CBC).
  2. American Concrete Institute (ACI).
    - a. ACI 303R - "Guide to Cast-In-Place Architectural Concrete Practice"
    - b. ACI 318 – "Building Code Requirements for Structural Concrete"
    - c. ACI 347R - "Guide to Formwork for Concrete"
  3. Standard Grading and Dressing Rules #17, West Coast Lumber Inspection Bureau (For Douglas Fir Form Lumber).
  4. U.S. Product Standard PS 1-83 (For Plywood Form Lumber).

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Form Material:
  - 1. Smooth Concrete exposed to view: 5/8 inch minimum APA Plyform or steel.
  - 2. Concrete concealed from view: 5/8 inch minimum APA Plyform, steel or clean and sound 1 x 8 Standard Grade Douglas Fir.
- B. Fiber Forms: Tubular column forms spirally constructed of laminated plies of fiber. Plies shall be laminated using a non-water sensitive adhesive and surface wax impregnated for moisture protection. Forms shall give a smooth and seamless appearance to the cast concrete. Provide reveals, as shown on the drawings, as supplied by the form manufacturer. Forms shall be as manufactured by Sonoco Products, plastic lined; Burke Smoothtube by Burke Co.; or approved equal.
- C. Form Clamps: Assembly to have cone washers, (1 inch break back) 3/8" inch center rod.
- D. Form Ties:
  - 1. Concrete exposed to view: Snap ties allowing full 1 inch break back.
  - 2. Concrete concealed from view: Snap ties or wire.
  - 3. Verify special spacing requirements with architectural drawings at exposed concrete.
- E. Spreaders: Metal (no wood).
- F. Form Coating: Non-grain and non-staining types of form coating that will not leave a residual matter on the face of the concrete or adversely affect proper bonding of any subsequent paint or other surface applications.
  - 1. Form coating containing mineral oils or other non-drying materials will not be permitted for any concrete work.
- G. Joint Tape: No. 471 plastic film tape 3 inches wide, as manufactured by the Industrial Tape Division of 3M Company.
- H. Expansion Joint Filler (Preformed): ½ inch thick; Flexcell by Celotex Corporation, Elastic Fiber Expansion Joint by Phillip Carey Mfg. Co., or Sealtight Fiber Expansion Joint by W.R. Meadows, Inc.
- I. Extruded Polystyrene Foam: ASTM C578 type IV. Dow Chemical Corp. "Styrofoam", UC Industries "Foamular", or approved equal.

## PART 3 - EXECUTION

### 3.01 FORM CONSTRUCTION

- A. Construct substantial forms to the shapes, lines, grades and elevations shown, sufficiently tight to prevent leakage of mortar, and tied, clamped and braced to prevent spreading, shifting or settling. Plywood joints shall be square and tight; plywood shall be arranged in such manner as to minimize number of joints and to provide a smooth, attractive finished concrete surface.
- B. Apply form coating to forms before reinforcing steel is in place.
- C. Sleeves, anchors and bolts, including those for angle frames, supports, ties and other materials in connection with concrete construction, shall be secured in position before the concrete is placed.

- D. Proper provisions shall be made for openings, blockouts, sleeves, offsets, sinkages, recesses and depressions required by other trades and suppliers prior to placing concrete.
  - 1. The Contractor shall also see that sleeves have been installed and other provisions have been made for the installation of mechanical, electrical and other equipment.
  - 2. Coordinate with all trades to insure proper placement of all items in forms and to provide proper blockouts wherever required.
- E. Concrete work out of alignment, level or plumb will be cause for rejection of the whole work affected and, if so rejected, such work shall be removed and replaced, as directed by Architect, with no additional cost to the Owner.
- F. Form Not Required: Concrete footings may be poured directly against cut earth where feasible and when the Architect's approval has been obtained.
  - 1. See structural drawings for requirements for placing concrete footings directly against earth without forms.
- G. Use  $\frac{3}{4}$  inch minimum wood chamfer strips typical at all exposed corners unless noted otherwise on drawings.

### 3.02 CLEANING OF FORMS

- A. All dirt, chips, sawdust, rubbish, water, etc. shall be completely removed from form by water hosing and air pressure before any concrete is deposited therein. No wooden ties or blocking shall be left in concrete except where indicated for attachment of other work.
- B. Thoroughly clean and patch all holes in formwork and re-coat as required before reusing. Forms not suited to obtain concrete surfaces and tolerances in conformity with Contract requirements will be rejected by Architect.
  - 1. Reuse of forming materials shall be limited only as required to produce the finishes as specified, free from blemishes and other defects unless covered by other building materials in which case blemish free concrete is not required.

### 3.03 INSPECTION OF FORMS

- A. Notify the Architect at least 48 hours in advance of the beginning of pouring operations and at the completion of formwork and location of all construction joints. An inspection of forms and joints will be made for approval of finished work and general layout only. The foregoing inspection shall in no way relieve the Contractor of responsibility of design and safety or formwork, bulkheads and shorings.

### 3.04 REMOVAL OF FORMS AND SHORING

- A. Do not remove forms until concrete has attained sufficient strength to support its weight and any construction loading. Concrete must be allowed to cure long enough to avoid damage during form removal. Contractor or his representative in charge of concrete construction shall be present during removal of forms and shores, and shall be personally responsible for safety of this operation at all times and under all conditions.
- B. As a minimum, formwork and shoring shall remain in place for the following periods:
  - 1. Concrete on grade: 24 hours
  - 2. Walls and Columns: 3 days
  - 3. Formwork may be removed and reshores installed before the times indicated above, provided the concrete has cured sufficiently to avoid damage when formwork is removed. Shores must be immediately replaced with reshores in a sequence designed to avoid inducing stress in the concrete member.

### 3.05 ADJUSTING AND CLEANING

- A. Upon completion of this Work, clean up and remove from Site all equipment and debris resulting from this work.
- B. Surfaces to be painted shall be smooth and free of substances such as dirt, wax, excessive latence, grease or materials that would prevent proper bonding of finishes.
  - 1. Removal of foregoing contaminants, and complete removal of parting and curing compounds affecting proper paint bond, shall be responsibility of this Section of Work. Sandblast cleaning shall not be employed without specific approval of Structural Engineer.

END OF SECTION 03 10 00

NOT FOR BID

SECTION 03 21 00  
REINFORCING STEEL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Requirements of Division 1 apply to all work of this Section.

1.02 SCOPE

- A. Unless noted otherwise, furnish and install reinforcing for all concrete, including dowels, chairs, spacers, bolsters, etc., necessary for supporting and fastening reinforcement in place as shown on the Drawings and specified herein.

1.03 RELATED WORK (See also Table of Contents)

- A. Concrete Formwork: Section 03 10 00.  
B. Cast-In-Place Concrete: Section 03 30 00.  
C. Concrete Unit Masonry: Section 04 22 00.

1.04 QUALITY ASSURANCE

- A. General:
1. Acceptable Manufacturers: Regularly engaged in the manufacture of steel bar and welded wire fabric reinforcing.
  2. Installer Qualifications: Installation shall be done only by an installation firm normally engaged in this business. All work shall be performed by qualified mechanics working under an experienced supervisor.
  3. Welding Qualifications: Welding procedures, welding operators and welders shall be qualified in accordance with AWS D1.4 - "Structural Welding Code Reinforcing Steel".
    - a. Welders whose work fails to pass inspection shall be re-qualified before performing further welding.
  4. Reinforcement Work shall conform to ACI 301 and ACI 318 Chapter 25, as minimum standards.
  5. Allowable Tolerances:
    - a. Fabrication:
      - 1) Sheared length: 1 inch.
      - 2) Depth of truss bars: Plus or minus ½-inch.
      - 3) Ties: Plus or minus ½-inch.
      - 4) All other bends: Plus or minus 1 inch.
    - b. Placement:
      - 1) Concrete cover to form surfaces: Plus or minus ¼-inch.
      - 2) Minimum spacing between bars: Plus or minus ¼-inch.
      - 3) Crosswise of members: Spaced evenly within 2 inches of stated separation.
      - 4) Lengthwise of members: Plus or minus 2 inches.
    - c. Maximum bar movement to avoid interference with other reinforcing steel, conduits, or embedded items: 2 bar diameters.
- B. Standards and References: (Latest Edition unless otherwise noted):
1. 2019 California Building Code (CBC).
  2. American Concrete Institute (ACI).
    - a. ACI 301 – "Specifications for Structural Concrete"



- b. ACI 315R - "Guide to Presenting Reinforcing Steel Design Details".
    - c. ACI 318 – "Building Code Requirements for Structural Concrete"
  - 3. American Society for Testing and Materials (ASTM).
    - a. ASTM A82 - "Cold Drawn Wire for Concrete Reinforcement".
    - b. ASTM A1064 - "Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete".
    - c. ASTM A615 - "Deformed and Plain Billet-Steel Bars for Concrete Reinforcement".
    - d. ASTM A706 – "Low Alloy Steel Deformed Bars for Concrete Reinforcement".
  - 4. Concrete Reinforcing Steel Institute (CRSI) - "Manual of Standard Practice".
  - 5. American Welding Standard (AWS).
    - a. AWS D1.4 - "Structural Welding Code – Reinforcing Steel".
- C. Submittals: (Submit under provisions of Section 01 33 00)
- 1. Shop Drawings: Prepare in accordance ACI 315R. Indicate bending diagrams, assembly diagrams, splicing and laps of bars and shapes, dimensions and details of bar reinforcing and assemblies. Correctness of all reinforcing requirements and work is the responsibility of Contractor. Identify such shop drawings with reference thereon to sheet and detail numbers from Contract Drawings.
    - a. Do not use scaled dimensions from Contract Drawings in determining the lengths of reinforcing bars.
    - b. No reinforcing steel shall be fabricated without approved shop drawings.
    - c. Any deviations from the contract documents must be clearly indicated as a deviation on the shop drawings.
    - d. Areas of high congestion, including member joints and embed locations shall be fully detailed to verify clearances and assembly parameters and coordination with other trades.
  - 2. Certified mill test reports of supplied reinforcing indicating chemical and physical analysis. Tensile and bend tests shall be performed by the mill in accordance with ASTM A615.
  - 3. Product Data:
    - a. Manufacturer's specifications and installation instructions for splice devices.
    - b. Bar Supports.
  - 4. Certificates of Compliance with specified standards.
    - a. Reinforcing bars.
    - b. Welded wire fabric.
    - c. Welding electrodes.
  - 5. Samples: Only as requested by Architect.
- D. Tests and Inspections:
- 1. A testing program is required prior to start of construction. Testing program to be done in compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - 2. All reinforcing steel whose properties are not identifiable by mill test reports shall be tested in accordance with ASTM A615. One Series of tests for each missing report to be borne by the Contractor.
  - 3. When inspections are indicated for reinforcement placement on the Structural drawings, a special inspector shall be employed to inspect reinforcing placement per CBC Section 1704.
  - 4. When tests are indicated for reinforcing steel on the structural drawings, the reinforcing steel used shall be tested in accordance with ASTM A615. One tensile and one bend test for each 2-1/2 tons of steel or fraction thereof, shall be made.
  - 5. Inspect shop and field welding in accordance with AWS D1.4, including checking materials, equipment, procedure and welder qualification as well as the welds. Inspector will use non-destructive testing or any other aid to visual inspection that he deems necessary to assure himself of the adequacy of the weld.

6. Tests and inspection shall be performed by Owners testing agency except when needed to justify rejected work, in which case the cost of retests and reinspection shall be paid by the Owner and backcharged to the Contractor.

#### 1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver reinforcement to project site in bundles marked with metal tags indicating bar size and length.
- B. Handle and store materials to prevent contamination.
  1. Store reinforcement in a manner that will prevent excessive rusting or coating with grease, oil, dirt, and other objectionable materials. Storage shall be in separate piles or racks so as to avoid confusion or loss of identification after bundles are broken.
- C. Deliver and store welding electrodes in accordance with AWS D1.4.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Reinforcement Bars: ASTM A615, Grade 60 for all bars.
  1. Bar reinforcement to be welded shall meet chemical requirements of ASTM A706.
  2. Longitudinal reinforcement in columns and beams of special moment-resisting frames and special reinforced shear walls shall meet the chemical requirements of ASTM A706.
- B. Stirrups and Ties: ASTM A615, Grade 60 for all bars.
- C. Steel Dowels: Same grade as bars to which dowels are connected.
- D. Welded wire Fabric: ASTM A1064.
- E. Tie Wires: FS-QQ-W-461, annealed steel, black, 16 gauge minimum.
- F. Welding Electrodes: AWS D1.4, low hydrogen, E70XX series.
- G. Bar Supports:
  1. Typical, unless noted otherwise; CRSI Class 2 wire supports.
    - a. Do not use wood, brick or other objectionable materials.
    - b. Do not use galvanized supports.
  2. Supports placed against ground: Pre-cast concrete blocks not less than 4 inches square with embedded wire.
- H. Mechanical Couplers: Comply with ACI 318 section 25.5.7.1

### PART 3 - EXECUTION

#### 3.01 FABRICATION

- A. Shop fabricate reinforcement to meet requirements of Drawings.
- B. Fabricate reinforcement in accordance with the requirements of ACI 315R where specific details are not shown or where Drawings and Specifications are not more demanding.
- C. Steel reinforcement shall not be bent or straightened in a manner that will injure the material.

Bars with kinks or bends not shown on the Drawings shall not be used. Heating of bars for bending will not be permitted.

- D. Reinforcing shall not be field bent or straightened without structural engineer's review.
- E. Provide offsets in rebar (1:6 maximum) where required to maintain clearances.

### 3.02 CONDITION OF SURFACES

- A. Examine surfaces and conditions receiving or affecting the work. Do not proceed until unsuitable conditions have been corrected.

### 3.03 GENERAL

- A. Concrete shown without reinforcing shall be reinforced as similar parts shown with reinforcing except where concrete is specifically noted to be unreinforced.

### 3.04 PLACEMENT

- A. All reinforcement shall be accurately set in place, lapped, spliced, spaced rigidly and securely held in place and tied with specified wire at all splices and crossing points. All wire tie ends shall point away from the form. Carefully locate all dowel steel to align with wall and column steel.
  - 1. Bars shall be in long lengths with laps and splices as shown. Offset laps in adjacent bars. Place steel with clearances and cover as shown. Bar laps shall be as indicated on the Drawings. Tie all laps and intersections with the specified wire.
  - 2. Maintain clear space between parallel bars not less than 1-1/2 times nominal diameter, but in no case shall clear space be less than 1-1/2 times maximum size concrete aggregate.
  - 3. Reinforcing dowels for slabs shall be placed as detailed. Sleeves may be used if reviewed by the Structural Engineer before installation. Install dowel through all construction and expansion joints for all slabs on grade.
- B. Bar Supports: Support and securely fasten bars with chairs, spacers and ties to prevent displacement by construction loads or placement of concrete beyond the tolerances specified. Conform to CRSI as a minimum standard.
- C. Steel Adjustment:
  - 1. Move within allowable tolerances to avoid interference with other reinforcing steel, conduits, or embedded items.
  - 2. Do not move bars beyond allowable without concurrence of Structural Engineer.
  - 3. Do not heat, bend, or cut bars without concurrence of Structural Engineer.
  - 4. Reinforcement shall not be bent after being embedded in hardened concrete.
- D. Splices:
  - 1. Splice reinforcing as shown.
  - 2. Lap Splices: Tie securely with wire to prevent displacement of splices during placement of concrete.
  - 3. Splice Devices: Install in accordance with manufacturer's written instructions. Obtain Structural Engineer's review before using.
  - 4. Do not splice bars except at locations shown without concurrence of Structural Engineer.
    - a. Where splices in addition to those indicated are required, indicate location on shop drawings clearly and highlight "for Engineer's approval".

- E. Welding:

1. Welding is not permitted unless specifically detailed on Drawings or approved by Engineer.
  2. Employ shielding metal-arc method and meet requirements of AWS D1.4.
  3. Welding is not permitted on bars where the carbon equivalent is unknown or is determined to exceed 0.55.
  4. Welding shall not be done within two bar diameters of any bent portion of a bar which has been bent cold.
  5. Welding of crossing bars is not permitted.
- F. Welded Wire Fabric: Install in long lengths, lapping 24 inches at end splices and one mesh at side splices. Offset laps in adjacent widths. Place fabric in approximately the middle of the slab thickness unless shown otherwise on the Drawings by dimension. Wire tie lap joints at 12-inch centers. Use concrete blocks to support mesh in proper position.
- G. Reinforcement shall be free of mud, oil or other materials that may reduce bond at the time concrete is placed. Reinforcement with tightly adhered rust or mill scale will be accepted without cleaning provided that rusting has not reduced dimensions and weights below applicable standards. Remove loose rust.
- H. Protection against rust:
1. Where there is danger of rust staining adjacent surfaces, wrap reinforcement with impervious tape or otherwise prevent rust staining.
  2. Remove protective materials and clean reinforcement as required before proceeding with concrete placement.
- I. Drawing Notes: Refer to notes on Drawings for additional reinforcement requirements.
- J. Mechanical and Electrical Drawings: Refer to Mechanical and Electrical Drawings for formed concrete requiring reinforcing steel. All such steel shall be included under the work of this Section.

END OF SECTION 03 21 00

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## SECTION 03 24 00

### FIBROUS REINFORCING

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all fibrous reinforcing, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete and proper installation.
- B. Section includes, but is not limited to:
  - 1. Polypropylene fibers used as concrete secondary reinforcement.
- C. Related Sections:
  - 1. Section 03 20 00 - Reinforcing Steel.
  - 2. Section 03 30 00 - Cast-in-Place Concrete.

##### 1.03 STANDARDS AND REFERENCES

- A. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
- B. ASTM C 1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
- C. Southwest Certification Services (SWCS), Omega Point Laboratories No. 8662-1.
- D. UL Report File No. R8534-11.

##### 1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
  - 1. Synthetic fiber reinforcement manufactured in ISO 9001:2000 certified facility.
  - 2. Minimum 10-year satisfactory performance history of specified synthetic fiber reinforcement.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: Submit manufacturer's product data, including application rate and mixing instructions.
- C. Samples: Submit manufacturer's sample of synthetic fiber reinforcement.
- D. Manufacturer's Certification:
  - 1. Submit manufacturer's certification that synthetic fiber reinforcement complies with specified requirements.
  - 2. Submit evidence of manufacturer's ISO 9001:2000 certification.
  - 3. Submit evidence of satisfactory performance history of synthetic fiber reinforcement.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver synthetic fiber reinforcement in manufacturer's original, unopened, undamaged containers and packaging, with labels clearly identifying product name, unique identification number, code approvals, directions for use, manufacturer, and weight of fibers.
- B. Storage:
  - 1. Store synthetic fiber reinforcement in clean, dry area indoors in accordance with manufacturer's instructions.
  - 2. Keep packaging sealed until ready for use.
- C. Handling: Protect synthetic fiber reinforcement during handling to prevent contamination.

1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00.
- B. Comply with the Manufacturer's Standard Requirements.

1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

1.10 EXTRA MATERIALS

Provide in accordance with Section 01 77 00 Project Closeout.

1.11 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 – PRODUCTS**

2.01 MANUFACTURER

Basis of Design: Propex Operating Company, LLC, PO Box 22788, Chattanooga, TN 37422.  
Toll Free (800) 621-1273. Website: [www.fibermesh.com](http://www.fibermesh.com)

2.02 SYNTHETIC FIBER REINFORCEMENT

- A. Synthetic Fiber Reinforcement: Fibermesh 300.
  - 1. Material: 100 percent virgin homopolymer polypropylene multifilament fibers, containing no reprocessed olefin materials.
  - 2. Conformance: ASTM C 1116, Type III.
  - 3. Fire Classifications:
    - i. UL Report File No. R8534-11.
    - ii. Southwest Certification Services (SWCS), Omega Point Laboratories No. 8662-1.
  - 4. Fiber Length: Graded and Single-cut lengths.
  - 5. Alkali Resistance: Alkali proof.
  - 6. Absorption: Nil.
  - 7. Specific Gravity: 0.91.
  - 8. Melt Point: 324 degrees F (162 degrees C).

**PART 3 – EXECUTION**

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Notify the Construction Manager and Architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- C. Correct conditions detrimental to timely and proper complete of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

3.02 MIXING

- A. Add synthetic fiber reinforcement to concrete mixture in accordance with manufacturer's instructions.
- B. Add synthetic fiber reinforcement into concrete mixer before, during, or after batching other concrete materials.
- C. Application Rate: Add synthetic fiber reinforcement at standard application rate of 1.5 pounds per cubic yard (0.90 kg/m<sup>3</sup>) of concrete.
- D. Mix synthetic fiber reinforcement in concrete mixer in accordance with mixing time and speed of ASTM C 94 to ensure uniform distribution and random orientation of fibers throughout concrete.
- E. Concrete shall be as specified in Section 03 30 00.

3.03 PLACING AND FINISHING

Placing and finishing concrete shall be as specified in Section 03 30 00.

**END OF SECTION**



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SECTION 03 30 00  
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. Requirements of Division 1 apply to all Work of this Section.

1.02 SCOPE

- A. Furnish, place and finish cast in place concrete and related work as indicated on the Drawings and specified here.
1. Install miscellaneous metal and other items furnished by other trades to be installed in concrete work.
  2. Provide facilities for job curing of test cylinders and transporting to Testing Laboratory.
- B. Provide grouting of steel base plates as indicated on the Drawings and specified here.

1.03 RELATED WORK (See also Table of Contents)

- A. Concrete Formwork: Section 03 10 00.
- B. Reinforcing Steel: Section 03 21 00.
- C. Mortar and Grout: 04 05 00.
- D. Structural Steel: Section 05 12 00.
- E. Metal Fabrications: Section 05 50 00.

1.04 QUALITY ASSURANCE

- A. Standards and References: (Latest Edition unless otherwise noted)
1. 2019 California Building Code (CBC).
  2. American Concrete Institute (ACI)
    - a. ACI 117 – “Specification for Tolerances for Concrete Construction and Materials”
    - b. ACI 211.1 – “Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete”
    - c. ACI 211.2 – “Standard Practice for Selecting Proportions for Structural Lightweight Concrete”
    - d. ACI 301 – “Specifications for Structural Concrete”
    - e. ACI 302.1R – “Guide to Concrete Floor and Slab Construction”
    - f. ACI 305R – “Guide to Hot Weather Concreting”
    - g. ACI 306R – “Guide to Cold Weather Concreting”
    - h. ACI 318 – “Building Code Requirements for Structural Concrete”
    - i. ACI 360R – “Guide to Design of Slabs-On-Ground”
  3. American Society for Testing and Materials (ASTM)
    - a. ASTM C31 – “Making and Curing Concrete Test Specimens in the Field”
    - b. ASTM C33 – “Concrete Aggregates”
    - c. ASTM C39 – “Compressive Strength of Cylindrical Concrete Specimens”
    - d. ASTM C42 – “Obtaining and Testing Drilled Cores and Sawed Beams of Concrete”
    - e. ASTM C94 – “Ready-Mixed Concrete”
    - f. ASTM C109 – “Test of Hydraulic Cement Concrete”
    - g. ASTM C143 – “Slump of Hydraulic Cement Concrete”
    - h. ASTM C150 – “Portland Cement”

- i. ASTM C172 – “Sampling Freshly Mixed Concrete by the Volumetric Method”
  - j. ASTM C192 – “Making and Curing Concrete Test Specimens in the Laboratory”
  - k. ASTM C260 – “Air-Entraining Admixtures for Concrete”
  - l. ASTM C330 – “Lightweight Aggregates for Structural Concrete”
  - m. ASTM C494 – “Chemical Admixtures for Concrete”
  - n. ASTM C567 – “Standard Test Method for Determining Density of Structural Lightweight Concrete”
  - o. ASTM C618 – “Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete”
  - p. ASTM C685 – “Volumetric Batching and Continuous Mixing”
  - q. ASTM C1157 – “Hydraulic-Cement”
  - r. ASTM C989 – “Standard Specification for Slag Cement for Use in Concrete and Mortars”
- B. Submittals: (Submit under provisions of Section 01 33 00)
- 1. Concrete mix designs. See “Mix Design” below. Include results of test data used to establish proportions.
  - 2. Certificates of Compliance from Manufacturer
    - a. Cement certificates per CBC Section 1910
      - 1. Cement without certificate shall not be used.
    - b. Aggregates
    - c. Admixtures
  - 3. Data regarding hardeners and sealers.
  - 4. Grout samples for sacked surface textures and colors upon Architects request only.
  - 5. Layout drawings for construction, control and expansion joints.
  - 6. Transit-mix delivery slips:
    - a. Keep record at the job site showing time and place of each pour of concrete, together with transit-mix delivery slips certifying contents of the pour.
    - b. Make the record available to the Architect for his inspection upon request.
    - c. Upon completion of this portion of the work, deliver the record and the delivery slips to the Architect.
  - 7. See Section 03 21 00 for reinforcing steel submittals.
- C. Tests and Inspections:
- 1. Provide special inspections and testing as described in the “Statement of Structural Special Inspections and Testing” within the structural drawings and as required by this section.
  - 2. A testing program is required prior to start of construction. Testing program to be done in Compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - 3. The following tests shall be made by a recognized testing laboratory selected by the Owner and approved by the governing agency. All tests shall be in accordance with the previously mentioned standards and ACI 318 Section 26.12. A complete record of all tests and inspections shall be kept per CBC Section 1910.
    - a. Compressive Strength: Make and cure in accordance with ASTM C-31. Test in accordance with ASTM C-39 and ACI 318 Section 26.12.
      - 1) A record shall be made of time and of locations of concrete from which samples were taken.
      - 2) Four identical cylinders shall be taken from each pour of 150 cubic yards or 5000 square feet or part thereof, being placed each day per ACI 318 Section 26.12.2. One cylinder shall be tested at age 7 days, and two at age 28 days unless otherwise specified. Preserve remaining cylinder for future use.
    - b. Drying Shrinkage: (applies to lightweight concrete only unless noted otherwise)

- 1) A record shall be made of time cylinders and of locations of concrete from which samples were taken.
- 2) Three identical 4" x 4" x 11" specimens shall be made from same concrete as used in structure. Percent of shrinkage shall be reported at 21 days after 7 day moist curing period. Average results of 3 specimens shall be used as the accepted value. The value for laboratory cast specimens shall not exceed .075%. If field test specimens are used in lieu of laboratory specimens, a tolerance of +33% may be used.
- 3) Test specimens in accordance with ASTM C157.
  - c. Concrete consistency (slump) shall be tested in accordance with ASTM C143.
4. Provide full time inspection per CBC Section 1705.3 during the taking of test specimens and during the placing of all concrete and embedded steel.
5. See Section 03 21 00 for reinforcing steel tests and inspections.
6. Provide concrete batch plant inspections per ASTM C685.

## PART 2 - PRODUCTS

### 2.01 MATERIAL

- A. Portland Cement: ASTM C 150, Type II or Type V. One brand of cement shall be used throughout to maintain uniform color for all exposed concrete.
- B. Concrete Aggregate: Fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, as well as combination of sizes when two or more are used, shall conform to grading requirements of appropriate ASTM Standards and ACI 318 Section 26.4.1.2.
  1. Concrete Aggregates for Standard Weight Concrete: ASTM C 33. Aggregate shall be crushed granite or Perkins type.
  2. Concrete Aggregates for Lightweight Concrete: ASTM C330 to produce concrete weighing no more than 116 pcf at 28 days. Aggregate shall be vacuum saturated expanded shale as produced through the rotary kiln method.
- C. Water: Clean and free from injurious amounts of oil, acids, alkali, organic matter and other deleterious substances; suitable for domestic consumption.
- D. Admixtures shall be subject to prior approval by the Architect, in accordance with ACI 318 Section 26.4.1.4. Calcium Chloride is not permitted.
  1. Water Reducing
    - a. ASTM C494 Type A - for use in cool weather.
    - b. ASTM C494 Type D - for use in hot weather.
  2. Air Entraining
    - a. Conform to ASTM C 260
  3. Fly Ash
    - a. Conform to ASTM C 618
  4. Mid-Range Water-Reducers
    - a. Master Builders "Polyheed" or approved equal.
  5. Fly Ash Pozzolan
    - a. Conforming to ASTM A-618 Class F
  6. Slag Cement
    - a. Conform to Grade 80, 100, or 120.
- E. Slab on Grade Vapor Retarder
  1. Vapor Retarder must have the following qualities:
    - a. 15 mil thickness minimum
    - b. WVTR less than 0.008 as tested by ASTM E 96
    - c. ASTM E 1745 Class A (Plastics)

2. Vapor Retarder Products
  - a. Stego Wrap Vapor Retarder by STEGO Industries LLC.
  - b. Perminator by W.R. Meadows.
3. Vapor Retarder Tape
  - a. Water Vapor Transmission Rate: ASTM E 96, 0.3 perms or lower
  - b. Minimum 6-mils thick
  - c. Minimum 3 3/4 inches wide
  - d. Manufactured from High Density Polyethylene
  - e. Pressure Sensitive Adhesive
- F. Sand: Clean, dry, well graded.
- G. Abrasive aggregate for non-slip finish: Fused aluminum oxide grits, graded 12/30. Use factory-graded rustproof and non-glazing material that is unaffected by freezing, moisture and cleaning materials.
  1. Products offered by manufacturers to comply with the above requirements include: A-H Alox; Anti-Hydro Waterproofing Co., Toxgrip; Toch Div. - Carbolite, or approved equal.
- H. Expansion Joint Filler:
  1. Joint fill shall be a preformed non-extruded resilient filler, saturated with bituminous materials and conforming to ASTM D 1751. Products shall be equivalent to Burke "Fiber Expansion Joint", W.R. Meadows "Fibrated Expansion Joint Filler", or approved equal.
- I. Bonding Agent: Sonneborn "Sonobond"; the Euclid Chemical Company "Euco-Weld"; Larsen Products Corp., "Weld-Crete" or approved equivalent.
- J. Concrete Sealer: Cure and Seal, as manufactured by the Euclid Chemical Company "Aqua-Cure VOX", Sonneborn "Kure-N-Seal WB", Burke "Spartan-Cote", W.R. Meadows "Intex" or approved equal conforming to ASTM C-309, Type I, Class B requirements, and conforming to State of California Air Resources Board VOC Regulations.
- K. Concrete Hardener/Sealer: Clear, water soluble, sprayable in-organic silicate based hardener/sealer or acrylic co-polymer resin. Products shall be equal to Euclid Chemical Company "Eucosil", Burke "Spartan-Cote", Sonneborn "Sonosil", W.R. Meadows "Pena-Lith", or approved equal and must conform to State of California Air Resources Board VOC Regulations.
- L. Concrete Cure: Water based curing compound conforming to ASTM C-309, Type 1, Class A and B, and AASHTO Specification M-148; Type 1, Class A and B requirements, and State of California Air Resources Board VOC Regulations. Product shall be equivalent to Euclid Chemical Company "Kurez VOX", Burke "No. 1127" or "Aqua-Resin Cure", W.R. Meadows "1100 Clear", or approved equal.
- M. Non-Shrink Grout: See Section 2.2.A.6.

## 2.02 CONCRETE

- A. Concrete Mixes:
  1. Type A Concrete:
 

Strength: 3000 lbs. per square inch at 28 days.

Maximum Aggregate Size: 1-1/2 inch.

Cement Content: As required by mix design (ACI 318 Section 26.4.3).

5.0 sacks per yard minimum.

Maximum Water to Cement Ratio: 0.58

Admixture: Water Reducing.

Weight: 145 lbs. per cubic foot

Use for unexposed foundation concrete except as otherwise specified. At Contractor's option, Type B concrete may be substituted for this.

2. Type B Concrete:  
Strength: 3500 lbs. per square inch at 28 days.  
Maximum Aggregate Size: 1 inch.  
Minimum Cement Content: As required by mix design. (ACI 318 Section 26.4.3).  
5.5 sacks per yard minimum.  
Maximum Water to Cement Ratio: 0.45  
Admixture: Water reducing.  
Weight: 145 lbs. per cubic foot  
Use for building slab on grade
  3. Type C Concrete:  
Strength: 4000 lbs. per square inch at 28 days.  
Maximum Aggregate Size: 1 inch.  
Minimum Cement Content: As required by mix design (ACI 318 Section 26.4.3).  
6.5 sacks per yard minimum.  
Maximum Water to Cement Ratio: 0.50  
Admixture: Water reducing.  
Weight: 145 lbs. per cubic foot  
Use for columns, beams, walls and overhead structural slabs except as otherwise specified
  4. Type D Concrete:  
Strength: 3500 lbs. per square inch at 28 days.  
Maximum Aggregate Size: 3/4 inch.  
Minimum Cement Content: As required by mix design (ACI 318 Section 26.4.3).  
6.0 sack per cubic yard minimum.  
Maximum Water to Cement Ratio: 0.52  
Admixture: Water reducing.  
Weight: 145 lbs. per cubic foot  
Use for normal weight concrete over metal deck
  5. Type E Concrete:  
Strength: 3,000 lbs. per square inch at 28 days.  
Maximum Aggregate Size: 3/4 inch.  
Minimum Cement Content: As required by mix design (ACI 318 Section 26.4.3).  
6.0 sacks per yard minimum.  
Maximum Water to Cement Ratio: 0.52  
Admixture: Water reducing.  
Air Entrainment: As required for UL rating (4%-7%)  
Weight: 113 ± 3 lbs. per cubic foot. (Equilibrium Density per ASTM C567)  
Use for lightweight concrete over metal deck.
  6. Grout shall be non-shrink, non-metallic, flowable Type "713" or "928" by BASF.
    - a. Metallic grout equivalent to Master Builders "Embeco" may be used only where covered by earth, concrete, or masonry.
    - b. Acceptance by Architect required before using.
- B. Consistency of Concrete: Concrete slump, measured in accordance with ASTM C 143, shall fall within following limits.
1. For General concrete placement (with no admixtures): 4 inch ± 1 inch.
  2. Mixes employing the specified mid-range water reducer shall provide a measured slump not to exceed 7 inch ±1 inch after dosing, 2 inch ±1 inch before dosing.

3. Concrete slump shall be taken at point of placement. Use water reducing admixtures as required to provide a workable consistency for pump mixers. Water shall not be added at the jobsite without written review by the structural engineer.
- C. Mix Design:
1. Initial mix design shall be prepared for all concrete in accordance with ACI 318 Section 26.4.3. Mix proportions shall be determined in accordance with ACI 318 Section 26.4.3 or 26.4.4. In the event that additional mix designs are required due to depletion of aggregate sources, aggregate not conforming to Specifications or at request of Contractor, these mixes shall be prepared as above.
  2. Contractor shall notify the Testing Laboratory and Architect of intent to use concrete pumps to place concrete so that mix designs can be modified accordingly.
  3. Fly ash shall not exceed 25% of the total cementitious material. Where slag is used to replace cement, slag shall not exceed 25% of the total cementitious material by mass. Ternary systems where more than one supplementary cementitious material is used are prohibited without consent of SEOR.
  4. Provide 6% air entrainment typical for exterior concrete exposed to freeze-thaw cycles.
  5. Owner's testing laboratory shall review all mix designs before submittal. A registered civil engineer with experience in concrete mix design shall review the concrete mixes.
- D. Mixing:
1. Equipment: All concrete shall be machine mixed. Provide adequate equipment and facilities for accurate measurement and control of materials.
  2. Method of Mixing:
    - a. Transit Mixing: Comply with ASTM C 94. Ready mixed concrete shall be used throughout, except as specified below.
    - b. On-Site Mixing: Use only if method of storing material, mixing of material and type of mixing equipment is approved by Architect. Approval of site mixing does not relieve Contractor of any other requirements of Specifications.
    - c. Mixing shall be in accordance with ASTM C94 or ASTM C685.
  3. Mixing Time: After mix water has been added, concrete shall be mixed not less than 1-1/2 minutes nor more than 1-1/2 hours. Concrete shall be rejected if not deposited within the time specified.
  4. Admixtures:
    - a. Air entraining and chemical admixtures shall be charged into mixer as a solution and shall be dispensed by an automatic dispenser or similar metering device. Powdered admixtures shall be weighed or measured by volume as recommended by manufacturer. Accuracy of measurement of any admixture shall be within plus or minus 3%.
    - b. Two or more admixtures may be used in same concrete, provided such admixtures are added separately during batching sequence, and provided further that admixtures used in that combination retain full efficiency and have no deleterious effect on concrete or on properties of each other.
    - c. All admixtures are to be reviewed by Structural Engineer prior to commencing this work.
  5. Retempering:
    - a. Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall be discarded, not retempered.
    - b. Indiscriminate addition of water to increase slump is prohibited.
    - c. When concrete arrives at project with slump below that suitable for placing, water may be added only if neither maximum permissible water-cement ratio nor maximum slump is exceeded. Water shall be incorporated by additional mixing equal to at least half of total mixing time required. Any addition of water above that permitted by limitation of water-cement ratio shall be accompanied by a quantity of cement sufficient to maintain proper water-cement ratio. Such additions shall only be used if approved by Architect. In any event, with or without addition of cement, not more than

2 gallons of water per cubic yard of concrete, over that specified in design mix, shall be added.

6. Cold Weather Batching: When average of the highest and lowest air temperature falls below 40 degrees F for more than three consecutive days, provide adequate equipment for heating concrete materials. No frozen materials or materials containing ice shall be used. When placed in forms, concrete placed in these temperatures shall have a minimum temperature based on dimensions of concrete sections placed per ACI 301.
7. Hot Weather Batching: Concrete deposited in hot weather shall have a placing temperature below 90 degrees F per ACI 301. If necessary, ingredients shall be cooled to accomplish this.

## 2.03 FLOOR LEVELING AND FILL MATERIALS

- A. Epoxy Concrete Mortar: Floor leveling, non-shrink trowel applied epoxy concrete mortar; TPM 115 General Polymers Corp., A-H Emery Epoxy Topping #170 Anti-Hydro Corp., or approved equal, where areas to fill are less than 1/4 inch thick.
- B. Concrete Mortar: Floor leveling, patching and repair, non-shrink trowel applied concrete mortar; Master Builders EMBECO 885, Euclid EUCO, or approved equal, where areas of fill are greater than 1/4 inch thick.
- C. Cementitious Floor Leveling Material: Shall be self-leveling or trowelable with a minimum 28 day compressive strength of 3000 psi in accordance with ASTM C-109. Material shall be equal to Quikrete No. 1249, Ardex V-800/K-55, Mapei "Ultra/Flex" or approved equal.

## PART 3 - EXECUTION

### 3.01 PLACEMENT

- A. Before any concrete is placed, the following items of work shall have been completed in the area of placing.
  1. Forms shall have been erected, adequately braced, cleaned, sealed, lubricated if required, and bulkheaded where placing is to stop.
  2. Any wood forms other than plywood shall be thoroughly water soaked before placing any concrete. The wetting of forms shall be started at least 12 hours before concreting.
  3. Reinforcing steel shall have been placed, tied and supported.
  4. Embedded work of all trades shall be in place in the forms and adequately tied and braced.
  5. The entire place of deposit shall have been cleaned of wood chips, sawdust, dirt, debris, hardened concrete and other foreign matter. No wooden ties or blocking shall be left in the concrete except where indicated for attachment of other work.
  6. Reinforcing steel, at the time the concrete is placed around it, shall be cleaned of scale, mill scale or other contaminants that will destroy or reduce bond.
  7. Concrete surfaces to which fresh concrete is to be bonded shall be brush cleaned to remove all dust and foreign matter and to expose the aggregate, and then coated with the bonding adhesive herein specified.
  8. Prior to placing concrete for any slabs on grade, the moisture content of the subgrade below the slabs shall be adjusted to at least optimum moisture.
  9. No concrete shall be placed until formwork and reinforcement has been approved by Architect. Clean forms of all debris and remove standing water. Thoroughly clean reinforcement and all handling equipment for mixing and transporting concrete. Concrete shall not be placed against reinforcing steel that is hot to the touch. Notify Structural Engineer 48 hours in advance of concrete pour.
- B. Conveying: Handle concrete from mixer to place of final deposit by methods which will prevent separation or loss of ingredients. Deposit concrete in forms as nearly as practicable at its final



position in a manner which will insure that required quality is obtained. Chutes shall slope not less than 4 inches and not more than 6 inches per foot of horizontal run.

- C. **Depositing:** Deposit concrete into forms in horizontal layers not exceeding 24 inches in thickness around building, proceeding along forms at a uniform rate and consolidating into previous pour. In no case shall concrete be poured into an accumulation of water ahead of pour, nor shall concrete be flowed along forms to its final place of deposit. Fresh concrete shall not be permitted to fall from a height greater than 6 feet without use of adjustable length pipes or, in narrow walls, of adjustable flexible hose sleeves. Concrete shall be scheduled so that placing is a continuous operation for the completion of each section between predetermined construction joints. If any concreting operation, once planned, cannot be carried on in a continuous operation, concreting shall stop at temporary bulkheads, located where resulting construction joints will least impair the strength of the structure. Location of construction joints shall be as shown on the drawings or as approved by Structural Engineer. The rate of rise in walls shall not be less than 2 feet per hour.
1. **Consolidation:** Concrete shall be thoroughly compacted and worked to all points with solid continuous contact to forms and reinforcement to eliminate air pockets and honeycombing. Power vibrators of approved type shall be used immediately following pour. Spading by hand, hammering of forms or other combination of methods will be allowed only where permitted by Structural Engineer. In no case shall vibrators be placed against reinforcing steel or used for extensive shifting of deposited fresh concrete. Provide and maintain standby vibrators, ready for immediate use.
  2. **Hot Weather Concreting:** Unless otherwise directed by the Architect, perform all work in accordance with ACI 305 when air temperature rises above 75 degrees F and the following:
    - a. **Mixing Water:** Keep water temperature as low as necessary to provide for the required concrete temperature at time of placing. Ice may be required to provide for the design temperature.  
**Aggregate:** Keep aggregate piles continuously moist by sprinkling with water.  
**Temperature of Concrete:** The temperature of the concrete mix at the time it is being placed in the forms shall not exceed 90 degrees F per ACI 301. The method employed to provide this temperature shall in no way alter or endanger the design mix or the design strength required.  
**Dampen subgrade and formwork** before placing concrete. Remove all excess water before placing concrete. Keep concrete continuously wet when air temperature exceeds 85 degrees F for a minimum of 48 hours after placing concrete. For slab on grade construction, see Section 3.1.E.  
**Protection:** Minimize evaporation from concrete in place by providing shade and windbreaks. Maintain such protection in place for 14 days minimum.
  3. **Cold Weather Concreting:** Follow recommended ACI 306 procedures when average of the highest and lowest air temperature falls below 40 degrees F for more than three consecutive days, as approved by Architect. Concrete placed in these temperatures shall have a minimum temperature based on dimensions of concrete sections placed as shown in ACI 301. No chemicals or salts shall be used to prevent freezing and no accelerating agents shall be used without prior approval from Architect.
- D. **Construction Joints:** Install only as indicated and noted on Drawings. Joints not indicated on Drawings shall be so located, when approved, as to least impair strength of structure, and shall conform to typical details. Construction joints shall have level tops, vertical sides. Horizontal construction joints shall be thoroughly cleaned and roughened by removing entire surface film and exposing clean aggregate solidly embedded in mortar matrix. Joints between concrete and masonry shall be considered construction joints. Vertical construction joints need not be roughened. See Drawings for doweling and required keys.
1. **Roughen construction joints** by any of following methods:
    - a. By sandblasting joint.

- b. By thoroughly washing joint, using a high pressure hose, after concrete has taken initial set. Washing shall be done not less than 2 hours nor more than 4 hours after concrete has been poured, depending upon setting time.
    - c. By chipping and wire brushing.
  2. All decisions pertaining to adequacy of construction joint surfaces and to compliance with requirements pertaining to construction joints shall be reviewed with the Structural Engineer.
  3. Just before starting new pour, horizontal and vertical joint surfaces shall be dampened (but not saturated).
  4. Before placing regular concrete mix, horizontal construction joint surfaces shall be covered with a layer of mortar composed of cement and fine aggregate of same proportions as that used in prescribed mix, but omitting coarse aggregate.
  5. For slabs, construction joints shall be in locations shown on plan. If not shown, locate at intervals not exceeding 150 feet in each direction. Refer to drawings for proper details for reinforcing at construction joints.
- E. Concrete Slabs on Grade:
  1. Exterior and interior concrete slabs on grade shall be poured as required under this Section. Base shall be accurately leveled and compacted prior to placing of concrete.
  2. Typically, interior slabs on grade shall be poured over a minimum of four (4 inch) inches of compacted crushed rock, unless otherwise indicated, over a vapor retarder.
  3. Protect slab on grade subbase from moisture prior to placing concrete. Avoid wetting rock layer to allow adequate concrete curing and avoid future vapor transmission. If the subbase has been wet excessively, verify that water has been eliminated prior to placement of concrete.
  4. Vapor Retarder installation shall be in accordance with manufacturer's instructions and ASTM E 1643.
    - a. Unroll Vapor Retarder with the longest dimension parallel with the direction of the pour.
    - b. Lap Vapor Retarder over footings and seal to foundation walls.
    - c. Overlap joints 6 inches and seal with specified tape.
    - d. Seal all penetrations (including pipes) per manufacturer's instructions.
    - e. No penetration of the Vapor Retarder is allowed except for reinforcing steel and permanent utilities.
    - f. Repair damaged areas by cutting patches of Vapor Retarder, overlapping damaged area 6 inches and taping all four sides with tape.
- F. Control Jointing - Slabs on Grade:
  1. Joints shall be in locations indicated on Drawings, or as directed by Architect.
  2. Joints in interior slabs shall be made by one of following methods:
    - a. By use of construction joints laid out in checkerboard pattern; pour and allow alternate slabs to set; fill out balance of checkerboard pattern with second pour.
    - b. By use of dummy groove joints at least 1/4 depth of slab, and at least 1/8 inch wide. These joints may be sawcut as soon as wet concrete can support the weight of the equipment and operator. Delaying sawcutting past this point will make jointing ineffective.
  3. Control jointing in exterior paving slabs shall be laid out in a checkerboard pattern; pour as described above, but with joint edges tooled to provide a uniform joint at least 3/8 inch in depth.
  4. Slab reinforcing need not be terminated at control joints.
  5. Construction and expansion joints shall be counted as control joints.
- G. Expansion Joints:
  1. Unless otherwise indicated, use 3/8 inch thick expansion joint filler. See Section 2.1.H
  2. Joints in interior slabs on grade shall be only in locations indicated.

3. Joints in exterior slabs on grade shall be installed at each side of structures, at curb transitions opposite apron joints, at ends of curb returns, at back of curb when adjacent to sidewalk, and at uniformly spaced intervals not exceeding 20 feet.
  4. Edges of concrete at joints shall be edger finished to approximately 3/8 inch radius.
  5. Interrupt reinforcing at all expansion joints.
- H. Score markings on exterior slabs on grade shall be located as indicated. Where not indicated, mark slabs into rectangles of not less than 12 square feet nor more than 20 square feet using a scoring tool which will leave edges of score markings rounded.

### 3.02 CURING AND PROTECTION

- A. Curing: Exposed surfaces of all concrete used in structure shall be maintained in a moist condition for at least 7 days after placing. The following final curing processes shall normally be considered to accomplish this. Concrete shall be maintained at not less than 50 degrees F nor more than 100 degrees F for a period of 72 hours after being deposited.
1. Flatwork to be exposed, stained, or painted shall have curing process submitted and approved by the architect prior to construction.
  2. Initial Curing Process - Flat Work:
    - a. Mist Spraying: As soon as troweling of concrete surfaces is completed, exposed concrete shall be sprayed continuously with a special atomizer spray nozzle, capable of producing a fine mist. Spraying shall be done without any dripping of water from nozzle. Amount of spraying shall be such as to maintain surface of concrete moist without any water accumulating on surface. Maintain spraying for a minimum of 12 hours, or until such time as hereinafter described curing process is applied. Mist spraying will not normally be required when the ambient air temperature is below 90 degrees F.
  3. Final Curing Process - Flatwork: Except as noted, use any of following:
    - a. Water Curing: Concrete shall be kept wet by mechanical sprinklers or by any other approved method which will keep surfaces continuously wet.
    - b. Saturated Burlap Curing: Finished surfaces shall be covered with a minimum of two layers of heavy burlap which shall be kept saturated during the curing period.
    - c. Curing Compounds: Membrane curing compounds of chlorinated rubber or resin type conforming to ASTM C309 may be used only if specifically approved by Architect. Use of membrane curing compound will not be permitted on surfaces to be painted, or to receive ceramic tile, membrane water-proofing or hardeners and sealers. Membrane curing compound may be used in areas to receive resilient floor tile, provided it is wax-free, compatible with adhesive used and approved by adhesive manufacturer. Agitate curing compounds thoroughly by mechanical means continuously during use and spray or brush uniformly in accordance with manufacturer's recommendations. Apply immediately following final finishing operation. All curing compounds shall conform to State of California Air Resources Board VOC Regulations.
    - d. Waterproof paper conforming to ASTM C 171, or opaque polyethylene film, may be used. Concrete shall be covered immediately following final finishing operation. Anchor paper or film securely and seal all edges in such a manner as to prevent moisture escaping from concrete.
  4. Curing Process - Formed Surfaces: Forms heated by sun shall be kept moist during curing period. If forms are to be removed during curing period, curing as described for flatwork shall be commenced immediately.
- B. Refer to Drawings for areas of concrete slab not to receive curing compounds or hardening compounds. Where concrete floors are to receive heavy duty coatings, waterproof coatings and the like, verify with coating installer the type of finish required for specified coating.

- C. Protection: Contractor shall be responsible for protection of finished concrete against injury by rain, cold, vibration, animal tracks, marking by visitors, vandalism, etc.
- D. Provide additional curing agents or compounds, not necessarily listed herein, but as recommended and or required for use with shake type hardeners or other special coatings and coverings by their manufacturers for a complete and proper installation.

### 3.03 FINISHES

#### A. Formed Surfaces:

- 1. Rough Form Finish: Surfaces shall be reasonably true to line and plane with no specified requirements for selected facing materials. Tie holes and defects shall be patched and fins exceeding 1/4 inch in height shall be rubbed down with wooden blocks. Fins and other rough spots at surfaces to receive membrane waterproofing shall be completely removed and the surfaces rubbed smooth. Otherwise, surfaces shall be left with the texture imparted by forms.
  - a. Rough finish shall be used for the following areas:
    - 1) Below grade and unexposed surfaces.
- 2.. Smooth Plywood Form Finish: Finish shall be true to line and plane. Tie holes and defects shall have been patched and ground with surface fins removed. Arrangement of plywood sheets shall be orderly, symmetrical, as large as practical and free of torn grain or worn edges. Surface concrete shall be treated with 1 part muriatic acid, in three parts water solution, followed immediately by a thorough rinsing with clear water. Surfaces which are glazed, have efflorescence, or traces of form oil, curing compounds or parting compounds shall be cleaned or treated to match other formed surfaces, except as otherwise indicated or specified.
  - a. Smooth Plywood Form Finish shall be used for the following areas:
    - 1) All surfaces above grade unless otherwise specified.
    - 2) At Contractor's option, may also be used in lieu of rough form finish.
- 3. Smooth Plastic Liner Finish: Surface shall be smooth, concrete free of honeycombing, air pockets larger than 1/8 inch in diameter, and fins.
  - a. This finish shall be used only where indicated on the Drawings.

#### B. Flatwork:

- 1. Unless otherwise indicated or specified, flatwork shall have an integral monolithic finish.
- 2. Integral Monolithic Finish: Apply as soon as freshly poured concrete slabs will bear weight of workers. Pour slabs full thickness to finish floor elevations indicated. At proper time, tamp surface repeatedly with a wire mesh or grid tamper in a manner to force aggregate down below surface and to bring sufficient mortar to surface to provide for a smooth coating of cement mortar over entire surface. Allow surface mortar to partially set, then float with wooden floats and finish with one of following, as required.
  - a. Broom Finish: Steel trowel surface to a smooth dense surface free of lines, tool marks, cat faces and other imperfections. After troweling, and before final set, give surface a broom finish, brushing in direction noted on Drawings, or as directed. A slip-resistant broom finish shall be used typically on exterior flatwork except as otherwise indicated or specified and shall be "medium" texture as approved by Architect.
  - b. Smooth Steel Trowel Finish: Apply 2 steel trowelings to obtain hard, smooth surface. All lips, irregularities, uneven levels, etc. shall be worked out before last troweling. All interior flatwork shall have a smooth steel trowel finish unless specified otherwise.
- 3. Tolerances:
  - a. For tolerances not indicated, refer to ACI 117.
  - b. Slabs on grade – Comply with  $F_F$  &  $F_L$  as specified by Architect, or at a minimum shall be sufficiently even to contact a 10' long straightedge with a tolerance of 1/8 inch.
  - c. Concrete over metal deck – Refer to Section 05 30 00 for minimum requirements.
  - d. Elevated slabs – Comply with Architectural requirements.

- e. Finished surfaces of exterior integral finished flatwork shall not vary more than 1/4 inch from a 10' long straightedge, except at grade changes.
- C. Sacked Surfaces: Exposed surfaces that are unacceptable in appearance to the Architect shall be sacked.
- 1. Prepare concrete surfaces in accordance with the referenced standards. Remove any form release materials by stoning by hand, power grinding or other method approved by the Architect.
  - 2. Prepare concrete surfaces to receive sack finishing with a light sand blasting.
  - 3. For best results, grout application and rubbing should be performed when areas to be treated are shaded and during cool, damp weather. When work is to be performed in hot and dry weather, a fog spray should be available for continuous use.
  - 4. Prepare grout samples for matching of concrete surfaces for approval by the Architect. These shall be made in the following proportions of gray cement to white cement to sand: 1:1:2, 1:2:3, and 2:1:3, etc. until the correct matching color is obtained on the test areas. Sand should be fine enough to pass the Number 30 sieve. Mixes should be made to a good workable consistency in a clean container and the mix with the best color chosen, or modified if needed.
  - 5. Provide sufficient quantities of sand and cement from the same source for the complete work at the job site.
  - 6. Mixing and Application:
    - a. Mixing of grout on the job should be timed for it to be used up within 1 to 1-1/2 hours.
    - b. Let the grout stand 20 to 30 minutes after mixing, and then remixed before applying.
    - c. Soak the concrete surface thoroughly with water at least 15 minutes before applying grout and again just before application so that the surface is adequately wet during the operation.
    - d. Apply grout with plasterer's trowel or sponge rubber float in sweeping strokes from the bottom up. Brush or spray gun applications may be used when approved by the Architect.
    - e. Work in freshly applied grout vigorously with a sponge rubber float, then let sit until some of its plasticity is gone but not until it loses its damp appearance. At this point it shall be rubbed with clean, dry burlap to remove the excess grout, leaving no visible film on the surface but filling all air holes.
    - f. Keep the surface wet for a day after grouting and sack rubbing are completed.
  - 7. Alternate methods of application and materials shall be subject to the approval of the Architect.

### 3.04 PATCHING

- A. Formed Surfaces:
- 1. Promptly upon removal of contact forms and after concrete surfaces have been inspected, form ties shall be removed and all necessary patching and pointing shall be expertly done.
  - 2. Honeycombed areas shall be removed down to sound concrete, coated with a bonding grout or approved compound and patched using a low shrinkage high bond mortar. Patched areas shall be cured by being kept damp for at least 5 days.
  - 3. Tie holes shall be cleaned, dampened and filled solid with patching mortar or cement plugs of an approved variety.
- B. Slabs on Grade: After entire slab is finished, shrinkage cracks that may appear shall be patched as follows:
- 1. Where slab is not exposed or where appearance is not important, cracks larger than 1/32 inch wide shall be filled with cement grout and struck off level with surface.
  - 2. Where slab is exposed and appearance is important, unsightly cracks shall be repaired in a manner satisfactory in appearance to Architect. If this cannot be accomplished, concrete shall be considered defective.

### 3.05 DEFECTIVE CONCRETE

- A. Defective concrete shall mean any of the following:
  - 1. Concrete not meeting 100 percent of the specified 28 day compressive strength.
  - 2. Concrete exhibiting rock pockets, voids, spalls, streaks, cracks, exposed reinforcing to extent that strength, durability, or appearance is adversely affected.
  - 3. Concrete significantly out of place, line, or level.
  - 4. Concrete not containing the required embedded items.
- B. Upon determination that concrete strength is defective:
  - 1. Should cylinder tests fall below minimum strength specified, concrete mix for remainder of work shall be adjusted to produce required strength. Core samples shall be taken and tested from cast-in-place concrete where cylinders and samples indicate inferior concrete with less than minimum specified strength.
    - a. Cores of hardened concrete shall be taken and tested in accordance with ASTM C 42 and C 39. Number and location of such cores shall be subject to the approval of Architect.
    - b. Cost of core sampling and testing will be paid for by the Contractor.
    - c. "85 percent" reduction in ACI 318 Section 26.12.4 will not justify low cylinder tests.
- C. Upon determining that concrete surface is defective, Contractor may restore concrete to acceptable condition by cutting, chipping, pointing, patching, grinding, if this can be done without significantly altering strength of structure. Permission to patch defective areas will not be considered a waiver of the right to require removal if patching does not, in the opinion of the Architect, satisfactorily restore quality and appearance.
- D. If core tests indicate that concrete is below the strength specified, or if patching does not restore concrete to specified quality and appearance, the concrete shall be deemed defective, and shall be removed and replaced without additional cost to the Owner.
- E. No repair work shall begin until procedure has been reviewed by the Architect and Structural Engineer.

### 3.06 SURFACE HARDENER AND SEALER

- A. Seal all interior exposed flatwork with clear sealer, except surfaces receiving ceramic tile, quarry tile, poured flooring or other special finishes specified, or as scheduled on the Drawings.
  - 1. Apply sealer in 2 or 3 coats, in accordance with manufacturer's directions, using the maximum quantity recommended.
    - a. Concrete floors must be thoroughly cured for a minimum of 30 days and completely dry before treatment.
    - b. Surfaces to be treated must be clean, free of membrane curing compounds, dust, oil, grease and other foreign matter.
    - c. Upon completion, concrete surfaces shall be clean and without discoloration or traces of excess hardener left on the surface.
- B. Apply sprayable hardener/sealer at locations as scheduled or as indicated on the Drawings. Apply in accordance with the manufacturer's favorably reviewed application instructions and recommendations.

### 3.07 GROUTING

- A. Prepare and place grout materials at locations as indicated on the Drawings in accordance with the manufacturer's recommendations and installation instructions.

- B. Pack grout materials solidly between bearing surfaces and bases or plates as indicated and to ensure no voids.

3.08 ADJUSTING AND CLEANING

- A. Remove all debris, excess materials, tools and equipment resulting from or used in this operation at completion of this work.

END OF SECTION 03 30 00

NOT FOR BID

SECTION 04 05 00  
MORTAR AND GROUT

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. The requirements of Division 1 apply to all Work of this Section.

1.02 SCOPE

- A. Provide all materials, labor and accessories as required and specified for complete mortar and grout installation in masonry walls.

1.03 RELATED WORK (See also Table of Contents):

- A. Reinforcing Steel: Section 03 21 00.  
B. Cast-In-Place Concrete: Section 03 30 00.  
C. Concrete Unit Masonry: Section 04 22 00.

1.04 QUALITY ASSURANCE

- A. Standards and References: (Latest Edition unless otherwise noted)
1. 2019 California Building Code (CBC)
  2. TMS 402-16 – Building Code Requirements for Masonry Construction
  3. TMS 602-16 – Specification for Masonry Structures
  4. ASTM C144 – Aggregate for Masonry Mortar.
  5. ASTM C150 – Portland Cement.
  6. ASTM C207 – Hydrated Lime for Masonry Purposes
  7. ASTM C270 – Standard Specification for Mortar for Unit Masonry
  8. ASTM C404 – Aggregates for Grout
  9. ASTM C476 – Standard Specification for Grout for Masonry
  10. ASTM C1019 – Method of Sampling and Testing Grout
- B. Tests and Inspections:
1. A testing program is required prior to start of construction. Testing program to be done in Compliance with CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  2. All tests and inspections herein are to be performed by an independent testing laboratory approved by the building official.
  3. Sample panel construction: For masonry governed by Level 2 or 3 Quality Assurance, construct sample panels of masonry walls per TMS 602 Article 1.6 D. The specifier has the option of permitting a segment of the masonry construction to serve as a sample panel or requiring a separate stand-alone panel.
  4. Mortar and Grout Tests: If mortar and grout tests are indicated as required on the Structural drawings, at the beginning of Masonry Work, at least 1 test sample each of mortar and grout shall be taken on 3 successive working days, then once per week with at least one sample taken for each 5000 square feet of wall area, or fraction thereof.
    - a. Test specimens shall be made in accordance with ASTM C1019 for grout and ASTM C780 for mortar.
    - b. Test specimens shall be continuously stored in moist air until tested.



5. If masonry placement and grouting inspection is indicated as required on the Structural Drawings, a special inspector shall be employed per CBC Section 1704 during the placement of all units, placement of all reinforcing steel, during all grouting operations and during taking of all test specimens.
- C. Submittals:
1. Mix design for mortar and grout shall be submitted for review.
  2. Supplier's certificates indicating materials comply with the specifications below. They shall include but are not necessarily limited to:
    - a. Aggregates
    - b. Cement
    - c. Admixtures

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Cement: ASTM C150, Type I or II, low alkali; natural gray.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Quicklime: ASTM C5.
- D. Lime Putty: Made from hydrated lime or quicklime.
  1. If made from quicklime, other than processed pulverized quicklime, slake lime and then screen through a No. 16 mesh sieve. Before using, store and protect slaked and screened lime putty for not less than 10 days.
  2. Processed pulverized quicklime shall be slaked for not less than 48 hours, and shall be cool when used.
  3. Lime putty prepared from hydrated lime may be used immediately after mixing.
  4. Lime putty prepared from quicklime or pulverized quicklime shall have a plasticity figure, after slaking and screening, of not less than 200, and shall weigh not less than 80 lbs. per cubic foot and not more than 90 lbs. per cubic foot. Lime putty prepared from hydrated lime shall conform to ASTM C207, Type S.
- E. Aggregate:
  1. For Mortar: ASTM C144.
  2. For Grout: ASTM C404.
- F. Admixture: "Sika Grout Aid", "BASF MasterPel 240MA"
- G. Water: Suitable for domestic consumption.

### 2.02 MORTAR

- A. Mortar shall be Cement-lime, Type S and shall conform to CBC Section 2103.2.
- B. Mortar shall be made with admixtures that are proportioned, added and mixed in strict accordance with manufacturer's directions. Calcium Chloride cannot be used in mortar mixes.
- C. Refer to architectural drawings for mortar color requirements.

### 2.3 GROUT

- A. Grout shall have a 28-day compressive strength of 2000 psi or f'm, whichever is greater. Grout shall conform to CBC Section 2103.3

- B. Fine Grout or Coarse Grout: The contractor is to determine the proper application of Fine Grout or Coarse Grout based on the grout pour height used and the clear grout space width for multi-wythe construction or clear grout space dimensions for hollow units in accordance with TMS 402 Table 3.2.1.
- C. Add grout admixture in accordance with the manufacturer's recommendations. Calcium Chloride cannot be used in grout mixes.

## PART 3 - EXECUTION

### 3.01 MIXING MORTAR AND GROUT

- A. Mix mortar and grout in accordance with TMS 602 Articles 2.6A and 2.6B.
- B. Accurately measure materials in suitably calibrated devices; shovel measurements are not acceptable.
- C. Place sand, cement and water in mixer in that order and mix for at least 2 minutes; then add lime putty and continue mixing as long as necessary to secure a uniform mass, but in no case less than 10 minutes.
- D. Use mixers of at least 1 sack capacity; batches requiring fractional sacks will not be permitted unless cement is weighed for each batch.

### 3.02 GROUTING PROCEDURES

- A. Specified under Sections 04 22 00.

### 3.03 RETEMPERING

- A. When necessary to retemper mortar, add water and remix; retempering by dashing water over mortar will not be permitted.
- B. Any mortar which is unused within 2-1/2 hours after initial mixing and any mortar that has begun to set shall not be used.

### 3.04 DEFECTIVE MORTAR OR GROUT

- A. Should the strength of mortar or grout fall below that specified, remainder of Work shall be adjusted to reach required strength. Work in place representing inferior grout and mortar and indicating a strength less than the minimum specified shall be tested by taking and testing core samples. Number and location of cores shall be determined by Structural Engineer.
- B. Should compression tests of cores fail to meet required strength, masonry shall be deemed to be defective and shall be removed and replaced at no cost to Owner.
- C. Costs relative to taking and testing of core samples shall be paid by Owner and will be deducted from Contract Amount. Cost of patching core holes shall be borne by Contractor.

END OF SECTION 04 05 00

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SECTION 04 22 00  
CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. The requirements of Division 1 apply to all Work of this Section.

1.02 SCOPE

- A. Furnish and install all concrete unit masonry, reinforcement, and all required accessories and materials as shown on the Drawings and specified here.
1. Cooperate with other trades for embedded items, furnished under those sections and installed here.
  2. Supervise setting of dowels for masonry furnished and installed under Section 03 21 00, Reinforcing Steel.

1.03 RELATED WORK (See also Table of Contents):

- A. Reinforcing Steel: Section 03 21 00.
- B. Cast-in-Place Concrete: Section 03 30 00.
- C. Mortar and Grout: Section 04 05 00.
- D. Structural Steel: Section 05 12 00.
- E. Miscellaneous Metal: Section 05 50 00.

1.04 QUALITY ASSURANCE

- A. Allowable Tolerances: Place masonry in accordance with section 3.3B.
- B. Standards and References: (Latest Edition unless otherwise noted):
1. 2019 California Building Code (CBC)
  2. TMS 402-16 – Building Code Requirements for Masonry Construction
  3. TMS 602-16 – Specification for Masonry Structures
  4. ASTM C90 – Specification for Loadbearing Concrete Masonry Units
  5. ASTM C140 – Standard Test Methods for Sampling and Testing of Concrete Masonry Units and Related Units
  6. ASTM C426 – Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units
- C. Submittals: Refer to Section 01 33 00 for submitting the following items:
1. Suppliers certificate indicating units comply with material standards indicated below:
  2. See Section 03 21 00 for reinforcing steel submittals.
- D. Tests and Inspections:
1. A testing program is required prior to start of construction. Testing program to be done in Compliance with CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  2. All tests and inspections herein are to be performed by an independent testing laboratory approved by the Building Official.

3. Sample panel construction: For masonry governed by Level 2 or 3 Quality Assurance, construct sample panels of masonry walls per TMS 602 Article 1.6 D. The specifier has the option of permitting a segment of the masonry construction to serve as a sample panel or requiring a separate stand-alone panel.
4. If masonry tests are indicated as required on the structural drawings, three sample units will be tested during construction for each 5,000 square feet of wall area. Test also three sample units prior to construction.
  - a. Units will be tested for compressive strength on both the net and gross area per ASTM C140.
  - b. Units will be tested for linear drying shrinkage per ASTM C426.
5. If masonry placement and grouting inspection is indicated as required on the structural drawings, a special inspector shall be employed per CBC Section 1704 to inspect the placement of all units, placement of all reinforcing steel, during all grouting operations and during taking of all test specimens.
6. See Section 03 21 00 for reinforcing steel tests and inspections.

#### 1.05 PRODUCT HANDLING

- A. Scaffolding, runways and ladders required for work under this Section shall be provided by masonry contractor, and shall be heavy trades type substantially built and in compliance with State labor laws, safety codes and other regulatory agencies as applicable to this project.
- B. Store masonry units off the ground in a dry location, covered and protected from absorbing moisture.
- C. Store masonry accessories, including metal items, in such a way as to prevent corrosion or accumulation of dirt and oil.

### PART 2 - PRODUCTS

#### 2.01 MASONRY UNITS

- A. Masonry units shall be hollow load bearing masonry units conforming to ASTM C90 and CBC Section 2103.1.
  1. Weight: Medium weight [Light weight].
  2. Maximum lineal shrinkage from saturated to oven dry condition of not more than 0.065 percent.
  3. Twenty-eight day compressive strength of 2000 psi.
  4. Moisture controlled units.
- B. Unit Type
  1. 8" wide by 8" high x 16" long unless specified otherwise.
- C. Provide bond beam units, open end units, lintel units and other special units as indicated. Use open end units at cells containing vertical reinforcement wherever possible.

#### 2.02 MORTAR AND GROUT

- A. Specified under Section 04 05 00.

#### 2.3 ACCESSORY MATERIALS

- A. Reinforcing Bars: ASTM A615, Grade 40 or 60, as indicated in Section 03 21 00, deformed bars. Where bars are to be welded, ASTM A706 Grade 60 bars shall be used.
  1. Tie Wire: Black annealed steel wire not lighter than 16 gauge.
- B. Ladder-type Joint Reinforcing: ASTM A951. Ladder-type joint reinforcing shall be comprised of 9-gauge side rods and 9-gauge cross rods at 16" on center and shall conform to ASTM

A951. Crossrods are to be butt welded to side rods. Ladder-type joint reinforcement shall be hot dip galvanized or stainless steel.

1. Width: Fabricate joint reinforcement in units with widths a minimum of 2" less than nominal width of walls. Provide mortar coverage over joint reinforcement of not less than 5/8" on joint faces exposed to exterior and 1/2" elsewhere.
- C. Provide spacers to firmly hold reinforcement in place.
- D. Anchor Bolts: All anchor bolts cast in masonry shall be headed studs or headed bolts with cut threads conforming to ASTM F1554 Grade 36 or ASTM A307 or ASTM A36 - as indicated on drawings.
- E. Expansion Anchors: All expansion bolts installed in masonry shall be Hilti Kwik Bolt 3 per ICC ESR-1385, Simpson Wedge-All per ICC ESR-1396 or Dewalt/Powers Power-Stud+ SD1 per ICC ESR-2966. See Structural Drawings for installation requirements, testing and special head requirements as applicable. Substitution of other brands or anchors shall proceed only after written approval from the Structural Engineer and the Building Official has been obtained.
- F. Adhesive Anchors: All drill and epoxy threaded rods shall be ASTM F1554 Grade 36 or Grade 50, as indicated on drawings, and installed in masonry with Hilti HIT-HY 270 per ICC ESR-4143, Simpson SET-XP per UES ER-265 or Dewalt/Powers AC100+ Gold per ICC ESR-3200. See Structural Drawings for installation requirements, testing and special head requirements as applicable. Substitution of other brands or anchors shall proceed only after written approval from the Structural Engineer and the Building Official has been obtained.
- G. Screw Anchors: All screw anchors installed in masonry shall be Hilti Kwik HUS-EZ per ICC ESR-3056, Simpson Titen HD per ICC ESR-1056 or Dewalt/Powers Screwbolt+ per ICC ESR-4042. See Structural Drawings for installation requirements, testing and special head requirements as applicable. Substitution of other brands or anchors shall proceed only after written approval from the Structural Engineer and the Building Official has been obtained.
- H. Anchor Finish:
1. Interior Exposure: All anchors, nuts and washers for use in interior environments free of potential moisture shall be manufactured from carbon steel and zinc coated.
  2. Exterior or Exposed Use: All anchors, nuts, and washers for use in exposed or potentially wet environments, or for attached of exterior cladding materials shall be galvanized or stainless steel. Galvanized anchors, nuts and washers shall conform to ASTM A 153. Stainless steel anchors shall be manufactured from 300 series stainless steel. and nuts and washers from 300 series or Type 18-8 stainless steel.
- G. Non-Metallic Expansion Joint Strips: Premolded, flexible cellular neoprene rubber filler strips complying with ASTM D1056, Grade RE 41E1, capable of compression up to 35% of width and thickness indicated.
- H. Premolded Control Joint Strips: Material as indicated below, designed to fit standard sash block and maintain lateral stability in masonry wall; size and configuration as indicated.
1. Premolded PVC Control Joint Strips. Strips shall be polyvinyl chloride complying with ASTM D 2287, Type PVC 654-4 with a durometer hardness or 90.

## 2.04 JOINTS

- A. All joints shall be 3/8" thick joints for concrete block. Tool exposed interior and exterior joints and concealed exterior joints to produce a dense slightly concave surface that is well bonded to unit at edges. Tool joints behind room base, switches, and outlet plates to produce a

smooth dense joint flush with the face of adjacent masonry units, where occurring on the job. Cut joints flush on concealed interior surfaces and surfaces to be plastered.

## 2.05 SEALER

- A. Contractor shall provide and install minimum two coats, BASF MasterProtect H107 masonry sealer, or equal, at all CMU walls. BASF MasterProtect H107 product, or equal, shall meet all state vapor requirements. Sealer shall be clear and non-gloss product.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas to receive masonry and verify following:
  - 1. That foundation surface is level to permit bed joint with range of 1/4 minimum to 3/4 inch maximum for partially grouted or 1-1/4" maximum for fully grouted.
  - 2. That edge is true to line to permit projection of masonry to less than 1/4-inch.
  - 3. That projecting dowels are free from loose scale, dirt, concrete, or other bond-inhibiting substances and properly spaced and located.
- B. Do not begin work before unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Clean concrete surfaces to receive masonry. Remove laitance or other foreign material lodged in surfaces by sandblasting or other means as required. Joints between concrete and masonry shall be considered construction joints. See Concrete specifications.
- B. Ensure masonry units are clean and free from dust, dirt, or other foreign materials before laying. Do not use damaged masonry units, damaged components of structure, or damaged packaged materials.
- C. Establish lines, levels, and coursing. Protect from disturbances.
- D. Provide temporary bracing during erection of masonry work. Maintain in place until masonry has set to provide permanent bracing.

### 3.03 COURSING

- A. Erect masonry in accordance with CBC Section 2104.
- B. Place masonry to lines and levels indicated to the following tolerances:
  - 1. Variation from Unit to Adjacent Unit: 1/32-inch max.
  - 2. Variation from Plane of Wall: 1/4-inch in 10 feet.
  - 3. Variation from Plumb: 1/4-inch in 10 feet; 1/2-inch maximum.
  - 4. Variation from Level Coursing: 1/8-inch in 3 feet; 1/4-inch in 10 feet; 1/2-inch maximum.
  - 5. Variation of Joint Thickness: 1/8-inch between masonry courses.
- C. Bond: Unless noted otherwise in Drawings, lay concrete masonry units in running bond with vertical joints located over score of unit in course below (and vice versa).
- D. Maintain masonry courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.
- E. Preserve the vertical continuity of cells in concrete unit masonry per Article 3.3E of TMS 602.

### 3.04 PLACING AND BONDING

- A. Do not install cracked, broken or chipped masonry units.
- B. Lay only dry concrete masonry units. Do not wet concrete masonry prior to laying up units unless written permission is obtained from the Engineer.
- C. Lay masonry in full bed of mortar, properly jointed with other work. Buttering corners of joints, and deep or excessive furrowing of mortar joints are not permitted.
  - 1. Block Cap: Lay with full mortar coverage on horizontal and vertical joints.
  - 2. Install grout cap where and as indicated.
- D. Fully bond intersections and external and internal corners.
- E. Do not shift or tap masonry units after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.
- F. Remove excess mortar.
- G. Perform job-site cutting with proper tools to provide straight unchipped edges. Take care to prevent breaking masonry unit corners or edges. Install cut units with cut surfaces and, where possible, cut edges concealed.
- H. Step back unfinished work for joining with new work. Do not use toothing.
- I. Provide cleanouts as indicated in "grouting" below.
- J. Matching Existing Masonry Work: Match coursing, bonding, color and texture of new masonry work with existing work wherever possible.

### 3.05 JOINTS

- A. Horizontal and vertical joints at masonry units shall be 3/8-inch wide and as follows:
  - 1. Point joint tight in unpurged masonry below ground.
  - 2. All end joints shall be fully filled with mortar and joints squeezed in bed joints shall be held back approximately 1/2-inch from cell to provide positive bond with grout.
  - 3. Joints shall be struck flush at all areas to receive plaster, stucco and any other finish material other than paint.

### 3.06 MASONRY REINFORCEMENT

- A. Place reinforcement in accordance with Article 3.4 B of TMS 602.
- B. Reinforcing steel shall not be bent or straightened in a manner that will damage the material. Bars with kinks or bends not shown on the plans shall not be used. Heating of bars for bending is not permitted.
  - 1. Bars shall conform accurately to the sizes, shapes, lines and dimensions shown on drawings and with hooks and beds made as detailed. Bars shall be placed as indicated on the drawings and centered on grout space.
  - 2. At the time grout is place around it, reinforcing steel shall be clean of mill scale or other coatings that will destroy or reduce bond.
  - 3. All vertical reinforcing steel shall be installed in one piece whenever practical, full height of wall, and braced throughout its height in a manner that will retain the steel in proper position and provide the proper clearance.



- C. Foundation dowels that interfere with unit webs are permitted to be bent to a maximum of 1 inch horizontally for every 6 in of vertical height.
- D. Reinforcing steel shall be secured to all foundation dowels and held in place at spacing not to exceed 192 bar diameters.

### 3.07 GROUTING

- A. General Requirements:
  - 1. All cells shall be grouted solid.
  - 2. Use of grout lifts above or below 5 feet 4 inches at Contractor's option.
  - 3. Use grout pump, hopper or bucket to place grout.
  - 4. Place grout in final position within 1-1/2 hours after introduction of mixing water.
  - 5. Stop grout approximately 1½ inches below top of last course; except at top course bring grout to top of wall. Do not form grout keys within beams.
- B. Grout pours 5 feet 4 inches or less:
  - 1. Do not lay units higher than 64 inches before grouting.
  - 2. If mortar has been allowed to set prior to grouting, remove all fins protruding more than ½-inch into grout space.
  - 3. Consolidate each lift with mechanical vibration twice per Article 3.5 E of TMS 602. Once while placing grout and once more after initial absorption of water but before set.
- C. Grout pours greater than 5 feet 4 inches:
  - 1. Layup walls, subject to maximum height limitations of Table 6 under Article 3.5 of TMS 602.
  - 2. Provide clean out holes at the bottom of every pour in cells containing vertical reinforcement. Construct clean out courses with open-bottom bond beam units inverted to permit cleaning of all cells by flushing. Cleanouts shall be not less than 3x4inch openings cut from one face shell. Do not plug clean out holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected.
  - 3. Clean mortar droppings from the bottom of the grout space and from reinforcing steel. Remove mortar fins protruding more than ½-inch into the grout space by dislodging the projections with a rod or stick as the work progresses or by washing the grout space at least twice a day during erection using a high-pressure stream of water.
  - 4. Do not place grout in hollow unit masonry until mortar joints have set for at least 24 hours and clean out plugs have cured 24 hours.
  - 5. Place grout in lifts not to exceed 12 feet 8 inches in height, with a waiting period between lifts, dependent on weather and absorption rate of the masonry, in order to place the succeeding lift after the preceding lift becomes plastic but prior to initial set. The first lift shall be consolidated using mechanical vibrators. After the required waiting period, place the second lift and consolidate with the vibrator, reconsolidating the lift below to a depth of 12 to 18 inches. Repeat the waiting, placing and consolidating process until the top of the grout pour is reached. Reconsolidate the top lift after the required waiting period. The high-lift grouting of any section of wall between lateral flow barriers shall be completed to the top of a pour in one working day unless a new series of clean out holes is established and the resulting horizontal construction joint cleaned.

### 3.08 WEATHER PROVISIONS FOR CONSTRUCTION

- A. Cold Weather Construction to be in accordance with Article 1.8 C of TMS 602.
- B. Hot Weather Construction to be in accordance with Article 1.8 D of TMS 602.

### 3.09 EXPANSION AND CONTROL JOINTS

- A. See drawings for type and location of expansion and/or control joints.
- B. Where control joints are not indicated on the drawings the Contractor shall submit a proposed control joint layout for Architect and Engineer approval. General guidelines for control joint locations are as follows:
  - 1. At major changes in wall height.
  - 2. At changes in wall thicknesses.
  - 3. At corresponding control joints in foundations, floors, or roof construction.
  - 4. Near wall intersections.
  - 5. At column centerlines.
- C. Maximum Spacing: Maximum control joint spacing in concrete masonry construction shall be such that the ratio of wall length to height shall not exceed 1.5 with a maximum spacing of 25 feet.

### 3.10 BOND BEAMS

- A. Bond beams shall be located where shown and detailed on the drawings, and shall be reinforced as indicated and as herein after specified.

### 3.11 BUILT-IN WORK

- A. Miscellaneous Embedded Items: All items indicated to be embedded in masonry shall be carefully located and anchored to prevent movement during grouting operations. Solidly grout spaces around built-in items. Consult other trades in advance and make provisions for installation of their work to avoid cutting and patching. Install chases minimum of one full masonry unit length for jamps.

### 3.12 CUTTING AND FITTING

- A. Obtain approval prior to cutting or fitting any area not indicated or where appearance or strength of masonry work may be impaired.

### 3.13 REPAIR, POINTING AND CLEANING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damage, or if units do not match adjoining units.
- B. Pointing: During the tooling of joints, enlarge any voids or holes and completely fill with mortar.
- C. Dry brush masonry surface after mortar has set, at each day's work and after final pointing.
- D. Leave work and surrounding surface clean and free of mortar spots and droppings.
- E. Cleaning: Upon completion of masonry installation, repair all holes. Defective joints shall be cut out and rejointed. Exposed masonry surfaces shall be cleaned free of mortar, green stain and efflorescence.

### 3.14 SEALER

- A. Contractor shall install sealer as directed by the manufacturer. Coverage and installation rates shall be as per manufacturer's recommendations. Install sealer in minimum two coats at the rates required.

### 3.15 DEFECTIVE MASONRY

- A. Materials or workmanship not conforming to appearance or strength specified, will be deemed defective and shall be removed and replaced at no cost to Owner.
- B. Defective mortar and grout, as defined under Section 04 05 00; "Mortar and Grout" shall constitute defective masonry.

END OF SECTION 04 22 00

NOT FOR BID

SECTION 05 12 00  
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Requirements of Division 1 apply to all Work of this Section.

1.02 SCOPE

- A. Furnish and install all structural steel as shown and specified including, but not necessarily limited to the following:
1. Prime coat painting and touch up.
  2. All cast-in-place anchor bolts, nuts, plates, etc.
  3. 10 gauge steel or 3/4 inch plywood templates for column anchor bolts.

1.03 RELATED WORK (See also Table of Contents)

- A. Metal Fabrications: Section 05 50 00.
- B. Cast-In-Place Concrete: Section 03 30 00.

1.04 QUALITY ASSURANCE

- A. General:
1. Comply with the referenced ASTM standards for materials.
  2. Perform all welding only with AWS certified welders.
  3. Verification of accuracy:
    - a. Engage and pay for a registered civil engineer or licensed land surveyor to check the alignment, plumbness, elevation, and overall accuracy of the erected framing at appropriate stages during construction and at completion of erection. Prior to erection, a survey shall be made of the as-built locations of all anchor rods and other embedded items associated with the attachment of structural steel. The party providing the survey shall submit written verification that the entire installation is in accordance with the contract documents and meets the allowable erection tolerances as set forth in the AISC "Code of Standard Practice for Steel Buildings and Bridges".
    - b. Columns shall be verified at each lift. Column shim details and procedures shall be submitted for review.
  4. Paint:
    - a. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use thinners approved by paint manufacturer, and use within recommend limits.
    - b. Coordination of Work: Review other Sections in which prime paints are to be provided to ensure compatibility of coatings system for various substrates. Upon request, furnish information or characteristics of finish materials to be used.
    - c. Requirements of Regulatory Agencies: Comply with applicable rules and regulations of governing agencies for air quality control.
- B. Except where other requirements are specified, comply with the following standards (latest edition unless noted otherwise)
1. AISC 360 "Specification for Structural Steel Buildings".
  2. AISC 303 "Code of Standard Practice for Steel Buildings and Bridges".
  3. AISC 341 "Seismic Provisions for Structural Steel Buildings"
  4. AISC 358 "Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications"

5. RCSC "Specifications for Structural Joints Using High Strength Bolts".
  6. AISC 303 Section 10, Architecturally Exposed Structural Steel, Code of Standard Practice for Steel Buildings and Bridges
  7. AWS D1.1 "Structural Welding Code - Steel" – latest edition
  8. AWS D1.8 "Structural Welding Code – Seismic Supplement" – latest edition
  9. ASTM A6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".
  10. SSPC-Vis 1 Pictorial Surface Preparation Standards for Painting Steel Structures
  11. SSPC-SP2 Hand Tool Cleaning
  12. SSPC-SP3 Power Tool Cleaning
  13. SSPC-SP6 Commercial Blast Cleaning
  14. SSPC-PA2 Measurement of Dry Paint Thickness with Magnetic Gauges
  15. California Building Code (CBC) – latest edition
- C. Submittals: (Submit under provisions of Section 01 33 00)
1. Product Data: Include laboratory test reports and other data to show compliance with specifications (include specified standards). Include certified copies of mill reports covering chemical and physical properties of each type of structural steel.
  2. Shop Drawings:
    - a. Shop drawings shall include complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.
    - b. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.
    - c. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.
    - d. Dimensions required to locate structural steel for manufactured items such as mechanical equipment, electrical equipment, dock levelers, etc., shall be coordinated and provided by the General Contractor. General Contractor shall also coordinate and provide dimensions to locate structural steel for window washing supports such as davits, tie-backs, etc.
  3. Procedures:
    - a. Provide weld procedures for both prequalified welds and special welds to be submitted to the Owner's Testing Laboratory and the Architect.
    - b. Provide installation procedure and inspection for direct tension indicator washers detailed in supplemental specifications provided by the manufacturer for approval.
    - c. Procedures shall be submitted for both shop and field welds.
- D. Tests and Inspections:
1. Provide special inspections and testing as described in the "Statement of Structural Special Inspections and Testing" within the structural drawings and as required by this section.
  2. Testing Laboratory:
    - a. All materials, work, methods and equipment shall be subject to inspection at the mill, fabricating plant and at the building site. Material or workmanship not complying fully with the Contract Documents will not be accepted. The Contractor shall give the Testing Laboratory reasonable notice when ready for inspection and shall supply samples and test pieces and all facilities for inspection without extra charge. The Owner will assume the expense of making the tests and inspection except as otherwise specified in Division 1.
  3. Cost of Testing and Inspection: Costs of testing and inspection of structural steel, except as specified hereunder and in Division 1, will be paid for by the Owner.
    - a. All transportation costs and per diem living costs for inspection at fabricators' plant further than 75 miles from the job site will be back-charged to the Contractor.
    - b. It is assumed that all fabrication will take place in one shop location only. All additional inspection costs will be back-charged to the Contractor.

- c. All mill tests and costs of re-test of plain materials shall be at the expense of the Contractor.
- d. Costs of tests required due to Contractor's failure to provide steel identifiable in accordance with the indicated ASTM designation shall be at the expense of the Contractor.
- 4. Structural Steel Testing and Inspection:
  - a. Structural Steel: If structural steel tests are indicated as required on the structural drawings, one tension and one bend test shall be made for each size of structural shape, plate and for each tube and pipe size. Tests to be made in accordance with requirements of appropriate ASTM designations.
  - b. If structural steel tests are not indicated as required on the structural drawings, then for shapes, plates, bars, pipe and tubing, manufacturer's certified mill test reports and analysis for each heat will be acceptable for steel identifiable in accordance with indicated ASTM designation. Mill test reports shall indicate the physical and chemical properties of all structural steel used. Correlate individual heat numbers with each specified structural section.
  - c. Unidentifiable Steel:
    - 1) For  $F_y$  less than or equal to 36.0 ksi : Provide one tension and elongation test and one bend for each 5 tons or fraction thereof for each size.
    - 2) For  $F_y$  greater than 36.0 ksi : Provide one tension and elongation test and one bend or flattening for each piece.
  - d. Costs of retests and additional testing required by the use of unidentifiable steels shall be the Contractor's responsibility. Additional costs of testing incurred by the Owner shall be deducted from the Contract Final Payment.
- 5. Expansion Anchors: Load test as indicated on drawings.
- 6. Welding Inspection:
  - a. For Moment Resisting Frame Welding inspection and testing requirements, see specification Section 05 12 24 - Welding of Moment Resisting Frames.
  - b. If shop or field welding inspection is indicated on the structural drawings or required by the applicable referenced standards, shop and field welded operations shall be inspected in accordance with AISC 360 by a qualified welding inspector employed by the Testing Laboratory. Such inspector will be a person trained and thoroughly experienced in inspection of welds. The inspector's ability to distinguish between sound and unsound welding will be reliably established
  - c. The welding inspector will make a systematic record of all welds. This record shall include:
    - 1) Identification marks of welders.
    - 2) List of defective welds.
    - 3) Manner of correction of defects.
  - d. The welding inspector will check the material, equipment and procedure, as well as the welds. He will also check the ability of the welder. He will furnish the Architect with a report, duly verified by him that the welding which is required to be inspected is proper, and has been done in conformity with the Contract Documents, and that he has used all means to determine the quality of the welds.
  - e. All full penetration groove welds will be subject to ultrasonic testing, as per AWS D1.1. All defective welds shall be repaired and retested with ultrasonic equipment at the Contractor's expense.
  - f. Column Flanges: An area extending 6 inches above and below point where girder flanges are attached will be inspected. Column flange edges will be inspected visually and entire area ultrasonically for lamination, plate discontinuities, and non-metallic inclusions.
  - g. When ultrasonic indications arising from the weld root can be interpreted as either a weld defect or the backing strip itself, the Engineer will be notified. The Engineer may require the removal of backing strip. The backing strip will be removed at the expense of the Contractor, and if no root defect is visible the weld will be retested. If no defect is indicated on this retest, and no significant amount of base and weld metal have

been removed, no further repair of welding is necessary. If a defect is indicated, it will be repaired and retested at Contractor's expense.

- h. The ultrasonic instrumentation will be calibrated by the technician to evaluate the quality of the welds in accordance with AWS D1.1.
  - i. Other methods of inspection, for example, X-Ray, gamma ray, magnetic particle, or dye penetrant, may be used on welds if felt necessary by the inspection laboratory, and with the approval of the Engineer.
  - j. Base metal thicker than 1-1/2 inches, when subjected to through thickness weld shrinkage strains, shall be ultrasonically inspected for discontinuities directly behind such weld before and after joint completion.
  - k. End-welded studs shall be sampled, tested, and inspected per the requirements of AWS D1.1.
  - l. At the discretion of the owner's testing agency, the ultrasonic testing frequency may be reduced but may not be less than the following:
    - 1) Initially, all welds requiring ultrasonic testing will be tested at the rate of 100 percent in order to establish the qualifications of each individual welder. If the reject rate is demonstrated to be less than 5 percent of the welds tested for each welder, then the frequency of testing for that welder may be reduced to 25 percent. If the reject rate increases to 5 percent or more, 100 percent testing will be re-established until the rate is reduced to less than 5 percent. The percentage of rejects will be calculated for each welder independently.
    - 2) A sampling of at least 40 completed welds will be made for such reduction evaluation. Reject rate is defined as the number of welds containing rejectable defects divided by the number of welds completed. For evaluating the reject rate of continuous welds over 3 ft in length where the effective throat is 1" or less, each 12 inch increment or fraction thereof shall be considered as one weld. For evaluating the reject rate of continuous welds over 3 ft in length where the effective throat is greater than 1", each 6 inch of length or fraction thereof shall be considered one weld.
7. High Strength Bolting Tests and Inspection:
- a. Furnish certified test reports for each lot of bolts in accordance with of ASTM A325 and A490. Install bolts under the supervision of a qualified inspector in accordance with, Research Council "Specifications for Structural Joints using ASTM A325 or A490 Bolts".
  - b. If high strength bolting inspection is indicated on the structural drawings or required by the applicable referenced standards, the testing laboratory shall provide inspection in accordance with AISC 360.
  - c. While the work is in progress, the Inspector shall determine that the requirements of this Specification are met in the work. The Inspector shall observe the calibration procedures and shall monitor the installation of bolts to determine that all plies of connected material have been drawn together and that the selected procedure is properly used to tighten all bolts.
    - 1) In addition to the requirement of the foregoing paragraph, for all connections specified to be slip critical (SC), the Inspector shall assure that the specified procedure was followed to achieve the pretension specified in the AISC. The pretension shall be verified by the inspector for these bolts.
    - 2) Bolts in connections identified as not being slip-critical nor subject to direct tension need not be inspected for bolt tension other than to ensure that the piles of the connected elements have been brought into snug contact.

#### 1.05 PRODUCT HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

- B. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

## 1.06 SEQUENCING/SCHEDULING

- A. Cooperate and coordinate this work with other trades for anchor bolts, and other required inserts, templates, etc. Align this work prior to installation of other materials.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Structural Steel: Except where indicated on drawings.
  - 1. W shapes: ASTM A572-50 or ASTM A992-50 unless indicated otherwise on drawings.
  - 2. Channels and other rolled shapes: ASTM A36 unless indicated otherwise on drawings.
  - 3. Angles, plates and bars: ASTM A36 unless indicated otherwise on drawings.
- B. AISC group 4 and 5 shapes and plates greater than 2 inches thick: ASTM A36 and/or ASTM A572 Grade 50 with supplementary requirements S91 Fine Austenitic Grain Size and S5 Charpy V-Notch Impact Test. For location of Charpy V-Notch test, see ASTM A6 Supplementary Requirement S30. Charpy V-Notch test shall be per ASTM A673, frequency P and shall meet a minimum average value of 20 ft-lbs absorbed energy at 70° F.
- C. Steel Tubing: ASTM A500, Grade C or ASTM A1085 Grade A.
- D. Steel Pipe: ASTM A53, Type E or S, Grade B.
- E. Anchor Bolts: All anchor bolts cast in concrete or masonry shall be headed bolts with cut threads conforming to ASTM F1554 grade 36, 55 (weldable per S1 Supplementary Requirements), or 105 as indicated on drawings.
- F. Machine Bolts: ASTM A307.
- G. High Strength Bolts, Nuts and Washers: Install in accordance with requirements for A325 and A490 slip critical and snug tight conditions as indicated on drawings. Install high strength bolts with snug tight type connections with threads included in shear plane except as otherwise noted. Install hardened washers in conformance with AISC Specifications.
  - 1. Bolt Specifications: Bolts shall conform to the requirements of the current edition of the Specifications of the American Society for Testing and Materials for High-Strength Bolts for Structural Steel Joints, ASTM A325, Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength, ASTM A490 as indicated on drawings.
  - 2. Bolt Geometry: Bolt dimensions shall conform to the current requirements of the American National Standards Institute for Heavy Hex Structural Bolts, ANSI Standard B18.2.1. The length of bolts shall be such that the end of the bolt will be flush with or outside the face of the nut when properly installed.
  - 3. Nut Specifications: Nuts shall conform to the current chemical and mechanical requirements of the American Society for Testing and Materials Standard Specification for Carbon and Alloy Steel Nuts, ASTM A563, Appendix Table X1.1. Provide Grade A Heavy Hex nuts for Grade 36 and 55 threaded rods. Provide Grade DH or ASTM A194-2H Heavy Hex nuts for Grade 105 threaded rod.
  - 4. Washers: Flat circular washers and square or rectangular beveled washers shall conform to the current requirements of the American Society for Testing and Materials Standard Specification for Hardened Steel Washers, ASTM F436. Washers for base plates shall be placed top and bottom of plate and shall be ASTM A36 square or circular unless ASTM F844 are permitted on the drawings.



5. Tension Control Fastener System: Bolts shall conform to the requirements of the current edition of the Specifications of the American Society for Testing and Materials for Twist Off Type Tension Control Structural Bolt/Nut/Washer Assemblies, ASTM F1852, providing equivalent properties to ASTM A325 or A490 as indicated on drawings.
- H. Headed Stud-Type Shear Connectors: ASTM A29-12, Grade 1010 through 1020, cold-drawn carbon steel with dimensions complying with AISC Specifications, with minimum physical properties as follows:
  1. Ultimate Tensile strength: 65,000 psi.
  2. Yield strength – 0.2% offset: 51,000 psi
  2. Elongation in 2 inches: 20 percent
  3. Reduction of area: 50 percent.
- I. Provide hexagonal heads and nuts for all connections per ASTM A563, Appendix Table X1.1.
- J. Electrodes for Welding: Comply with AWS Code, E70 Series minimum. Fabricator to select proper electrodes according to weld procedures as submitted.
- K. Shop Primer – See Section 3.4, Painting and Cleaning
- L. Power-Actuated Fasteners (Shot Pins): Tempered steel pins with special corrosive resistant plating or coating. Pins shall have guide washers to accurately control penetration. Fastening shall be accomplished by low-velocity piston-driven power activated tool. Pins and tool shall be as manufactured by Hilti Fastening Systems.
- M. Expansion Bolts: Hilti Fastening Systems “Kwik-Bolt Concrete Expansion Anchors” to concrete; Ramset “Dynabolt Sleeve Anchors” to masonry or approved equal.

## PART 3 - EXECUTION

### 3.01 FABRICATION

- A. Shop Fabrication and Assembly: Fabricate and assembly structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated to provide the flattest floor possible. The contractor shall coordinate member tolerances with finishes.

Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

- B. Connections: Weld or bolt shop connections, as indicated. Bolt field connections, except where welded connections or other connections are indicated.
- C. Unless noted otherwise, make holes 1/16 inches larger than the nominal bolt diameter.
- D. Welding, Shop and Field: Weld by shielded arc method, submerged arc method, flux cored arc method, or other method approved by AWS. Perform welding in accordance with AWS Code. All welders, both manual and automatic, shall be certified in accordance with AWS "Standard Qualification Procedure" for the Work to be performed. See paragraph "welding" herein, for detailed requirements. If sizes of fillet welds are not shown on drawings, use AWS minimum weld size but not less than 3/16 inch fillet welds.

- E. Bolt Holes for Other Work: Provide holes required for securing other work to structural steel framing.

Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

Cut, drill, or punch holes perpendicular to metal surfaces and remove all burrs. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

- F. AISC Group 4 and 5 shapes and built up members shall meet the requirements for joints in AISC Sections J1.5, J1.6, J2.7 and M2.2.

- G. High Strength Bolts:

1. Installation and Tightening:

- a. Handling and Storage of Fasteners: Fasteners shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the shift. Fasteners shall not be cleaned of lubricant that is present in as-delivered condition.
- b. Tension Calibrator: A tension measuring device shall be required at all job sites where bolts in slip-critical joints are being installed and tightened. The tension measuring device shall be used to confirm: (1) the suitability to satisfy the requirements of AISC for the complete fastener assembly, including lubrication if required to be used in the work, (2) calibration of wrenches, if applicable, and (3) the understanding and proper use by the bolting crew of the method to be used. The frequency of confirmation testing, the number of tests to be performed and the test procedure shall be as specified in 1.d. below, as applicable. The accuracy of the tension measuring device shall be confirmed through calibration by an approved testing agency at least annually.
- c. Joint Assembly and Tightening of Shear/Bearing Connections: Bolts in connections not within the slip-critical category shall be installed in properly aligned holes, but need only be tightened to the snug tight condition. The snug tight condition is defined as the tightness that exists when all plies in a joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. If a slotted hole occurs in an outer ply, a flat hardened washer or common plate washer shall be installed over the slot.
- d. Joint Assembly and Tightening of Connections Requiring Full Pre-tensioning. Slip-critical connections shall be installed in properly aligned holes and tightened by one of the following methods.
  - 1) Turn-of-nut Tightening: When turn-of-nut tightening is used, hardened washers are not required except as specified in the AISC. A representative sample of not less than three bolts and nuts of each diameter, length and grade to be used in the work shall be checked at the start of work in a device capable of indicating bolt tension. The test shall demonstrate that the method of estimating the snug-tight condition and controlling turns from snug tight to be used by the bolting crews develops a tension not less than five percent greater than the tension required for slip-critical connections.
  - 2) Installation of Alternate Design Bolts: A representative sample of not less than three bolts of each diameter, length and grade shall be checked at the job site in a device capable of indicating bolt tension. The test assembly shall include flat hardened washers, if required in the actual connection, arranged as in the actual connections to be tensioned. The calibration test shall demonstrate that each bolt develops a tension not less than five percent greater than the tension required by AISC. Manufacturer's installation procedure shall be followed for installation of bolts in the calibration device

and in all connections. When alternate design features of the fasteners involve an irreversible mechanism such as yield or twist-off of an element, bolts shall be installed in all holes of the connection and initially brought to a snug tight condition. All fasteners shall then be tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners prior to final twist-off or yielding of the control or indicator element of the individual fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic tightening.

- e. Mark bolts that have been completely tightened with an identifying symbol.

### 3.02 WELDING

- A. General: Quality of materials and design and fabrication of all welded connections shall conform to AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Building," AWS Code for Welding in Building Construction," and requirements of this section. Where members and connections are noted in the construction documents as being part of the seismic lateral force resisting system (LFRS), the requirements of AWS D1.8 Structural Welding Code – Seismic Supplement shall apply.

Location and type of all welds shall be as shown. Make no other welded splices, except those shown on drawings, without prior approval of the architect.

- B. Automatic Welding: Use electrode wire and flux for automatic and semi-automatic welding acceptable to Structural Engineer. All methods, sequences, qualification and procedures, including preheating, and post heating if necessary, shall be detailed in writing and submitted to the Structural Engineer for review.
- C. Qualification of Welders:
  - 1. Structural steel welding: Manual and automatic welds for structural steel construction shall be made only by operators who have been previously qualified by tests, as prescribed in AWS D1.1 to perform type of work required.
  - 2. Welders shall be checked by welding inspector. Those not doing satisfactory work may be removed, and may be required to pass qualification tests again. All qualification testing shall be at the Contractor's expense.
  - 3. Only welders whose weld procedures and pre-qualification by testing that have passed shall be considered qualified for such welds.
- D. Control cooling process after weld is completed by either step down post heat or thermal blankets as determined by procedures and prequalification.
- E. Box columns and built-up members shall have ultrasonic testing before and after welding.
- F. Flame cut surfaces shall be ground to remove contaminated steel layer to provide welds proper fusion without impurities.
- G. Preparation of surface: Surfaces to be welded shall be free of loose scale, slag, rust, grease, paint, and any other foreign material.
- H. Welding equipment: Welding equipment to be used in each case shall be acceptable to welding inspector. Use equipment with suitable devices to regulate speed, and manually adjust operating amperage and voltage. The amperage capacity shall be sufficient to overcome line drop, and to give adequate welding heat.
- I. Remove runoff tabs and grind surfaces smooth where the tabs would interfere with fireproofing and architectural finishes.

- J. End-welded studs:
  - 1. Automatic end-welded studs: Automatically end-weld in accordance with the manufacturer's recommendations in such a manner as to provide complete fusion between the end of the stud and the plates. There shall be no porosity or evidence of lack of fusion between the welded end of the stud and the plate. The stud shall decrease in length during welding approximately 1/8 inch for 5/8 inch, and 3/16 inch for 3/4 inch diameter. Stud sizes indicated on drawings represent the finish stud height.
  - 2. Fillet-end welded studs: Studs may be welded using prequalified FCAW, GMAW, or SMAW processes provided the requirements of the AWS D1.1.
- K. Provide mill camber as shown on the construction documents within AISC tolerance. Place mill tolerance upward for all beams specified no camber.

### 3.03 ERECTION

- A. Structural steel erection: Comply with AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Building", latest edition.
- B. Erection Sequence: Erect steel in accordance with special erection sequences where special erection sequences are indicated on the contract documents.
- C. Before and during erection, keep all structural steel clean. Ship, handle and store steel in manner to avoid injury to members. Steel members showing evidence to rough handling or injury will be rejected.
- D. Mark each member with erection identification corresponding to mark shown on erection drawings. Carefully plan erection of structural steel so that no cutting and removal of material will be necessary. Do not torch burn in the field, unless specifically permitted by Engineer.
- E. Provide sufficient bracing, shoring and guys to effect safe and satisfactory erection. Provide bracing and shoring capable of holding steel work plumb and properly aligned while field connections are being made, and until lateral force resisting elements are deemed by Architect capable of bracing structure. Temporary bracing shall be adequate to resist lateral forces from wind or seismic prior to the completion of the lateral resisting system.
- F. Set bearing and base plates with extreme care. Bring level, to line and grade with leveling plates or by leveling nuts and bolts. Grout solid under plates with a flowable non-shrink grout per Section 03 30 00 prior to applying vertical load.
- G. Field Assembly: Set structural framing accurately to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces which will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

Shimming or other adjustments not indicated on drawings shall be approved by the Engineer prior to installation. Level and plumb individual members of the structure within specified AISC tolerances except as noted herein. Column shimming shall be 1/4 inch.

- H. All welds shall be full and clean, and conform to AISC and AWS specifications.
- I. Erection Tolerances: Individual pieces shall be erected so that the deviation from plumb, level and alignment shall not exceed 1 to 500 plus:
  - 1. The maximum displacement of the center line of columns adjacent to elevator shafts, from the established column line, shall not be more than 1 inch at any point.

2. In order to provide a true, flat plane for the exterior elevations, install all steel framing at the exterior walls of the building, so that the center lines of such framing does not vary by more than 1 inch for the length of the building. Also install each vertical member on such grids so that its vertical center line does not vary by more than 1/2 inch from a vertical line for each story and 1 inch for its full height.
  3. All columns and beams shall adhere to Section M2.7 of the referenced "Specification for Structural Steel for Buildings" which states that completed members shall be free of twists, bends, and open joints. Take special care that column base plates are parallel and perpendicular to faces of columns and that bolt holes are accurately placed.
- J. Temporary Flooring:
1. Provide planking and scaffolding necessary in connection with erection of structural steel, support of erection machinery, and construction materials. Temporary floors and use of steel shall be as required by applicable regulatory requirements.
  2. If steel decking is used as a working platform, it shall be temporarily tack-welded to supports to extent necessary for such use in accordance with applicable regulatory requirements. The concentrated loading from welding machines and other heavy machinery required for steel erection shall be distributed by planking or other approved means. Metal decking that becomes damaged as the result of being used as a working platform shall be replaced at no additional cost to the Owner.
- K. Tower Crane: The design for the support and bracing for a tower crane shall be the responsibility of the General Contractor. The design shall be prepared by a structural engineer licensed in the state of California. Drawings and calculations shall be stamped and signed by the structural engineer. Concentric, torsional, and/or eccentric loading to the main structure shall be resolved by the addition of structural steel for shear tabs, stiffeners, drag ties, bracing struts, etc., Such items shall be designed, detailed, furnished and installed by the contractor.

### 3.04 PAINTING AND CLEANING

- A. Prior to prime coat application, clean all loose rust, mill scale, oil, dirt, and all other materials from all steel to be left exposed. Use hand tool, power tool, sandblasting, chemical cleaning, and any other method necessary to provide a smooth, sound surface for painting.
- B. Shop prime all steel except the following:
1. Steel encased in concrete.
  2. Contact surfaces for slip-critical (sc) high strength bolts.
  3. Areas within 4 inches of field welds.
  4. Tops of members to receive metal decking.
  5. Steel to be fireproofed.
  6. Surfaces to be galvanized.
- C. Use the following Type A shop painting systems on all normal environment interior steelwork:
1. Surface Preparation: SSPC-SP2 Hand Tool Cleaning or SSPC-SP3 Power Tool Cleaning. Where jobsite exposure is expected to exceed 6 months, SSPC-SP6 Commercial Blast Cleaning is required.
  2. Application: Follow coating manufacturer's printed directions.
  3. Material: Type A Tnemec Company, Inc., Series V10; Sherwin Williams Steel Spec Universal; Metal Case 94-231 Series or approved equal
  4. Number of Coats: One
  5. Dry Film Thickness: 2.0 mils minimum.
  6. Volume Solids: 56.0 +/- 2.0% minimum
  7. Generic Description: Modified Alkyd.

- D. Unless noted otherwise in subsection H, use the following Type B shop painting systems on all exterior steelwork and interior steelwork subjected to wet conditions or fumes (see subsection H for additional requirements)
1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning
  2. Application: Follow coating manufacturer's printed directions.
  3. Material: Type B Tnemec 90-97 Tneme-Zinc primer or approved equal
  4. Number of Coats: One
  5. Dry Film Thickness: 2.5 to 3.5 mils
  6. Volume Solids: 63% +/- 2%
  7. Generic Description: Zinc-Rich Urethane
- E. Unless noted otherwise in subsection H, use the following finish painting systems on all exterior steelwork and interior steel work subjected to wet conditions or fumes (see subsection H for additional requirements):
1. Application: Follow coating manufacturer's printed directions. Apply over Type B primer system above.
  2. Material: Tnemec Series 750 UVX paint or approved equal
  3. Number of Coats: One
  4. Dry Film Thickness: 2.5 to 5 mils
  5. Volume Solids: 72% +/- 2%
  6. Generic Description: Polyfunctional Hybrid Polyurethane
- F. Primers and paints shall meet all federal and state environmental and air quality requirements.
- G. Apply two shop prime coats to areas which will be inaccessible after erection.
- H. All exterior steelwork and all interior steelwork subjected to wet conditions or fumes, including all welds, bolts, washers and other connection components, shall be primed and painted or hot-dip galvanized, as specified by the Architectural finish specifications. In the absence of Architectural finish specifications, all exterior steelwork and all interior steelwork subjected to wet conditions and fumes, including all welds, bolts, washers and other connection components, shall be hot-dip galvanized, conforming to the requirements set forth in ASTM A123/A123M and ASTM A153/A153M.
- I. Clean contact surfaces of high strength bolts of all burrs and material which might prevent solid seating of the parts. Steel to receive bolts shall be primer painted except beneath the contact area of slip-critical bolts.
- J. After erection, field touch up all welded areas, high strength bolts and damaged areas. For all steel to remain exposed, remove all blemishes, paint drips, and touch up prime coat.

### 3.05 HOISTING AND BRACING

- A. Provide all hoisting and erecting equipment and power.
- B. Provide and maintain any and all safety railings, toe boards, etc., required for the erection of steel framing and metal decking.
- C. Brace the erected frame in a manner which will assure safety and proper alignment to receive the metal decking and until the concrete slabs have been poured and have set.
- D. Erect building frame true and level. Erect columns in a manner to allow for movement due to welding shrinkage and thermal expansion and contraction of framing. Check plumbness after erection of each level. Maintain structural stability of frame during erection. Provide temporary

bracing where necessary to maintain frame stability and to support required loads, including equipment and its operation.

END OF SECTION 05 12 00

NOT FOR BID

SECTION 05 40 00  
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. The requirements of Division 1 apply to all Work in the Section.

1.02 SCOPE

- A. Furnish and install all components and related items pertaining to cold-formed metal framing systems.

1.03 RELATED WORK SPECIFIED ELSEWHERE (See also Table of Contents)

- A. Cast-in-place concrete: Section 03 30 00.  
B. Structural Steel: Section 05 12 00.  
C. Metal Deck: Section 05 30 00.

1.04 QUALITY ASSURANCE

- A. General:
1. Welders: Qualified for welding in horizontal, vertical, and overhead positions in accordance with AWS D1.3.
  2. Wall system shall provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperatures.
  3. Wall system shall accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
- B. Standards and References: (Latest Edition unless noted otherwise)
1. California Building Code (CBC),
  2. ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process..
  3. Framing components shall conform to Standards of the Steel Stud Manufacturers Association (ICC-ES ER-3064P).
- C. Submittals: (Submit under provisions of Section 01 33 00).
1. Manufacturers catalog with sizes to be used indicated.
  2. ICC-ES report.
  3. Mill certificates verifying steel properties.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect metal framing units from rusting and damage.
- B. Deliver to Project site in manufacturer's unopened containers or bundles, identified with name, brand, type and grade.
- C. Store off ground in a dry ventilated space or protect with suitable waterproof covering.



## PART 2 - PRODUCTS

### 2.01 ACCEPTED MANUFACTURERS

- A. Members of the Steel Stud Manufacturer's Association (SSMA), or approved equal.

### 2.02 METAL FRAMING

- A. System Components: Provide steel studs, joists, tracks, straps, runners, blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories as shown on the Drawings for applications indicated. All studs, joists, tracks, and blocking shall conform to ICC-ES ERS-3064P.
- B. Materials and Finishes:
- 54 Mils (16 Gauge) and Thicker: Fabricate metal framing components of structural quality (SQ) steel sheet with a minimum yield point of 50,000-psi, conforming to ASTM A653, SS Grade 50 Class 1 or ASTM A1003, Grade 50 Type H (ST50H).
  - 43 Mils (18 Gauge) and Thinner: Fabricate metal framing components of structural quality (SQ) steel sheet with a minimum yield point of 33,000-psi, conforming to ASTM A653, SS Grade 33 or ASTM A1003, Grade 33 Type H (ST33H).
  - Finish: Galvanized complying with ASTM A653, G60. Finish accessories to match main framing components.
- C. See drawings for section properties and details.
- D. Studs and joists shall be of the size, shape, and gauge indicated, with a flange and flange return lip as shown on the Structural Drawings.
- E. Welding Electrodes: E60XX (43 Mil material and thinner), E70XX (54 Mil material and thicker)
- F. Galvanizing Repair Paint: High zinc-dust content paint for repair of galvanized surfaces damaged by welding.
- G. Material Thickness: All sections are to be roll formed in various depths with the following minimum bare metal thicknesses:

Minimum Thickness (inch)	Minimum Design Thickness (inch)	Gauge	Mils
0.0179	0.0188	25	18
0.0329	0.0346	20	33
0.0428	0.0451	18	43
0.0538	0.0566	16	54
0.0677	0.0713	14	68
0.0966	0.1017	12	97
0.1180	0.1240	10	118

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Install metal framing systems in accordance with the Structural Drawings. Where drawings conflict with manufacturer's recommendations, the Structural Drawings will govern.

B. Runner Tracks:

1. Install continuous tracks sized to match studs. See Structural Drawings.
2. Align at base and tops of studs.
3. Attach tracks with screws, welding, bolting or shot pins as indicated on the Structural Drawings.
4. Fasten corners and ends of tracks as shown.

C. Studs:

1. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces.
2. Where studs abut structural columns or walls, anchor ends of stiffeners to supporting structure.
3. Secure studs to top and bottom runner tracks by screw fastening at both flanges.
4. Install studs in one piece for full height; splicing of studs is not permitted.
5. Provide deflection allowance of 1/2" minimum in stud track, directly below horizontal building framing for all non-bearing wall framing. See Structural Drawings.
6. Install ends of studs tight to web of track at all bearing wall framing. Compress track against end of stud as required to achieve tight fit prior to installation of stud to track screw attachments. See Structural Drawings.
7. Install supplementary backing and bracing wherever walls or partitions are indicated to support equipment, services, casework, heavy trim and furnishings and similar work requiring attachment to wall or partition. Comply with stud manufacturer's instructions and industry standards.
8. See Structural Drawings for opening framing.
9. Frame both sides of expansion and control joints, with separate studs; do not bridge the joint with components of stud system.
10. Install one row of metal blocking or bridging at mid-height of all studs over 10'-0" in height in addition to bracing that may be required at studs that do not receive sheathing (see item 11 below).
11. Install strapping to all sides of studs that do not receive sheathing as indicated on the structural drawings.

3.02 TOUCH-UP PAINTING

- A. Touch-up shop-applied protective coatings damaged during handling and installation.
- B. Use compatible primer for prime coated surfaces; use galvanizing repair paint for galvanized surfaces.

END OF SECTION 05 40 00

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SECTION 05 50 00  
METAL FABRICATIONS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Requirements of Division 1 apply to all Work of this Section.

1.02 SCOPE

- A. Shop fabricated metal items and miscellaneous metal work.
- B. Refer to Schedule at end of this Section.

1.03 RELATED WORK (See also Table of Contents)

- A. Structural Steel: Section 05 12 00.

1.04 QUALITY ASSURANCE

- A. Standards and References: (Latest Edition unless otherwise noted)
  - 1. California Building Code (CBC)
  - 2. American Society for Testing and Materials (ASTM) Specifications as listed in the Section.
- B. Submittals: (Submit under provisions of Section 01 33 00)
  - 1. Shop Drawings: Submit shop drawings indicating profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevation, and details where applicable. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.
  - 2. Manufacturer's descriptive data: Submit for manufacturer's items.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver all parts ready for erection; store in close proximity to final locations.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel Sections: ASTM A36.
- B. Steel Tubing: ASTM A500, Grade C or ASTM A1085 Grade A.
- C. Steel Pipe: ASTM A53, Type E or S, Grade. B.
- D. Steel Bolts, Nuts, and Washers: ASTM A307.
- E. Welding Materials: AWS D1.1; type required for materials being welded.
- F. Galvanizing: Hot-dip process ASTM A123 typical and ASTM A153 for threaded fasteners performed after fabrication into largest practical section. Weight of coating not less than 2 oz. per sq. ft. of surface. Where damaged, repair surface with one coat of hot process galvanizing repair compound, "Galvalloy", Galvweldalloy", or approved equal.
- G. Primer: Tnemec Company "Series V10 Red Primer", Sherwin-Williams "Steel Spec Universal Primer"; or approved equal.

- H. Dissimilar Materials: Separate dissimilar surfaces in contact with or in close proximity to non-compatible metals, concrete masonry, or plaster with neoprene gasket; or other approved means.
- I. Expansion Bolts: Hilti "Kwik Bolt TZ" Expansion Anchor Bolts, galvanized unless otherwise indicated.
- J. Non-shrink Grout: Master builders 928 or equal.

## 2.02 FABRICATION

- A. Verify dimensions on site prior to shop fabrication.
- B. Fabricate items with joints tightly fitted and secured.
- C. Fit and shop assemble in largest practical sections, for delivery to jobsite.
- D. Grind exposed welds flush and smooth adjacent finished surfaces. Ease exposed edges to small uniform radius.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of structure, except where specifically noted otherwise.
- F. Make exposed joints butt tight, flush and hairline.
- G. Supply components required for anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, except where specifically noted otherwise.

## 2.03 FINISH

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact bond with concrete or where field welding is required.
- C. Prime paint interior items with one coat unless scheduled to be galvanized.
- D. Galvanize exterior items and scheduled interior items to minimum 2.00 oz/sq ft zinc coating.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Obtain Architect's approval prior to site cutting or making adjustments not scheduled.
- B. Clean and strip primed steel items to bare metal where site welding is scheduled.
- C. Make provision for erection loads with temporary bracing. Keep work in alignment.
- D. Supply items required to be cast into concrete with setting templates, for installation under appropriate Sections.

### 3.02 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Perform field welding in accordance with AWS D1.1.

C. After installation, touch-up field welds, scratched or damaged surfaces with primer, except repair exposed galvanized work (not to be painted) with hot process field galvanizing, in accord with manufacturer's published directions.

### 3.03 SCHEDULE

A. Provide and install items listed in Schedule and shown on Drawings with anchorage and attachment necessary for installation. The following Schedule lists principal items only. Refer to drawing details for items not specifically scheduled.

1. Miscellaneous plates or angles not attached to structural steel; complete with anchorage for embedment.
2. Exterior mounted ladders.
3. Handrails and guardrails.
4. Bollards.
5. Gates for trash enclosure.

END OF SECTION 05 50 00

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## SECTION 05 52 00

### METAL RAILINGS

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. General: Fabricate, supply and install site metal railings as shown in Drawings and as specified herein, including all accessories and hardware for a complete, timely and proper installation.
- B. Additional:
  - 1. Field measuring for weld plates, sleeves and insert locations.
  - 2. Field measuring.
  - 3. Anchors or inserts precast concrete.
  - 4. Prime painting of galvanized materials

##### 1.03 STANDARDS AND REFERENCES

- A. American Architectural Manufacturers Association (AAMA)
- B. American Concrete Institute (ACI): ACI 347 Recommended Practice for Concrete Formwork
- C. American Institute of Steel Construction (AISC)
- D. American Iron and Steel Institute (AISI)
- E. American National Standards Institute (ANSI)
  - 1. ANSI A21.1 Safety Requirements for Floor and Wall Openings, Railings and Toe Boards.
  - 2. ANSI A58.1 Minimum Design Loads in Buildings and Other Structures.
  - 3. ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities.
- F. American Society for Testing and Materials (ASTM)
  - 1. A 29 Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for.
  - 2. A 47 Specification for Ferritic Malleable Iron Castings.
  - 3. A 48 Specification for Gray Iron Castings.
  - 4. A 53 Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless.
  - 5. A 108 Steel Bars, Carbon, Cold Finished, Standard Quality.
  - 6. A 123 Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
  - 7. A 500 Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
  - 8. A 570 Specification for Steel, Sheet and Strip, Carbon, Hot Rolled, Structural Quality.
  - 9. A 575 Specification for Steel Bars, Carbon, Merchant Quality, M Grades.



10. A1264-1 Safety Requirements for Workplace Floor and Wall Openings, Stairs and Railing Systems
  11. C 595 Specification for Blended Hydraulic Cements.
  12. E 84 Test Method for Surface Burning Characteristics of Building Materials.
  13. E 894 Standard Test Methods for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
  14. E 935 Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
  15. E 985 Specification for Permanent Metal Railing Systems and Rails for Buildings.
- G. American Welding Society (AWS): Specifications for Welding Rods and Bare Electrodes.
- H. Americans With Disabilities Act Accessibility Guidelines (ADAAG)
- I. National Association of Architectural Metal Manufacturers (NAAMM) and National Ornamental and Miscellaneous Metals Association (NOMMA): Metal Finishes Manual
- J. National Association of Architectural Metal Manufacturers (NAAMM): Pipe Railing Manual and Metal Stair Manual
- K. National Fire Protection Association (NFPA): 101 Life Safety Code

1.04 QUALITY ASSURANCE

- A. Fabricator and Installer Qualifications: Furnish references listing projects of similar size and scope.
- B. Regulatory Requirements:
1. Components and installation are to be in accordance with state and local code authorities
  2. Components and installation are to follow current ADA and ICC/ANSI A117.1 guidelines.
- C. Structural Requirements:
1. Railing assembly shall withstand a minimum concentrated load of 200 pounds applied vertically downward or horizontally in any direction, but not simultaneously, at any point on the top rail.
  2. Guard intermediate rails, balusters, panel fillers, posts or cables shall be designed for a uniform load of not less than 50 pounds per square foot applied horizontally over the gross area of the guard of which they are part. Reactions due to this loading need not be added to the loading specified for the main supporting members of the guard.
  3. Railing frame components and cable hardware shall be designed to withstand loads encountered without excessive deflection or distortion when cables are tensioned to conform to building code requirements.

1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
1. Show sections and plans of stairs, dimensions and assembly of components.
    - a. Railings
    - b. Handrail

- c. Brackets
  - d. Reinforcements
  - e. Anchors
  - f. Welded and bolted connections
- 2. Show all field connections
- 3. Provide setting diagrams for installation of anchors, location of pockets, weld plates for attachment of rails to structure, and blocking for attachment of wall rail.
- 4. Specify adequate back up support for anchoring handrail bracket.
- 5. Indicate all required field measurements.
- 6. Submit one set of digital files for approval.
- 7. Indicate component details, materials, finishes, connection and joining methods, and the relationship to adjoining work.
- B. Submit manufacturer's installation instructions under provisions of Section.
- C. Certifications
  - 1. Furnish certification that all components and fittings are furnished by the same manufacturer or approved by the primary component manufacturer.
  - 2. Furnish certification that components were installed in accordance to the manufacturer's engineering data to meet the specified design loads.
- D. Samples:

Submit duplicate samples of railing showing style and finish. One approved sample will be returned to contractor.
- E. Pre-Installation Meeting
  - 1. Prior to the beginning of work, conduct a pre-job conference at the job site.
  - 2. Provide seven calendar days advance written notice ensuring the attendance by competent authorized representatives of the fabricator, building owner's representative, architect and subcontractors whose work interfaces with the work of this section.
  - 3. Review the specifications to determine any potential problems, changes, scheduling, unique job site conditions, installation requirements and procedures and any other information pertinent to the installation.
  - 4. Record the results of the conference and furnish copies to all participants.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01 66 00 Product Storage and Handling Requirements.
- B. Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.
- C. Storage on site:
  - 1. Store material in a location and in a manner to avoid damage. Stacking shall be done in a way, which will prevent bending.
  - 2. Store material in a clean, dry location away from uncured concrete and masonry. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.

3. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of material.

1.08 PROJECT CONDITIONS

Comply with the requirements of Sections 01 50 00 Construction Facilities.

1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

1.10 EXTRA MATERIALS

Provide in accordance with Section 01 77 00 Project Closeout.

1.11 RECORD DRAWINGS

Provide in accordance with Section 01 77 00 Project Closeout.

1.12 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties and Bonds.

**PART 2 - PRODUCTS**

2.01 MANUFACTURER

Basis of Design: Railing pipe and components shall be as manufactured or supplied by The Wagner Companies; P.O. Box 423, Butler, WI 53007. Phone: 888-243-6914. Fax: 414-214-0550. Web site: www.wagnercompanies.com. E-mail: info@mailwagner.com

2.02 MATERIALS AND FINISHES

Steel:

A. Pipe: ASTM A 53

B. Castings: Malleable, Ductile, Grey Iron meeting ASTM [A 47] [A 48]

C. Finish (refer to NAAMM/NOMMA Metal Finishes Manual):

1. Surface Preparation: Remove loose scale, rust, grease, oil, moisture or other foreign materials to properly prepare the surface for subsequent coating application.

Remove mill scale, rust and dirt following SSPC SP2 for hand cleaning and SSPC SP3 for power tool cleaning.

2. Galvanizing:

- a. Products fabricated from shapes, plates, bars and strips shall be galvanized in accordance with ASTM A 123.
- b. Sheet products shall be galvanized in accordance with ASTM A 653 and ASTM A 653M.
- c. Minimum coating weight 0.90 oz/sq. ft.

3. Paint:

- a. Minimum one coat of rust-inhibitive primer, FS-TT-P-641 Zinc Dust-Zinc Oxide Primer Coating (for Galvanized Surfaces) and FS-TT-P-645 Alkyd Type, Zinc Chromate, Paint Primer.
- b. Painted finish shall be as indicated in the Drawings.
- c. Touch up for Galvanized Surfaces: Use paint primer meeting FS-TT-P-645.

### 2.03 RAILING SYSTEM

- A. Material shall conform to 2.02 and be finished in accordance with 2.02.
- B. Railing system shall be permanently anchored].
- C. Rails and Posts: Fabricate rails and posts from steel pipe with nominal size of 1 1/2", (1.900" outside diameter) Schedule 40 (.140" wall).
- D. Pickets: .750" diameter, 0.050" wall steel tubing.
- E. Toe Board: Provide Toe Board of matching material as required.

### 2.04 FASTENERS

- A. All mechanical fasteners used in the assembly of stainless steel or aluminum railings shall be manufactured from stainless steel.
- B. Exposed mechanical fasteners for use with bronze materials shall be manufactured from yellow brass.
- C. Cement: Hydraulic, ASTM C 595, factory prepared with accelerator.

### 2.05 FABRICATION

- A. Form rail-to-end post connections and all changes in rail direction by miter elbows.
- B. Cut material square and remove burrs from all exposed edges, with no chamfer.
- C. Make exposed joints butt tight and flush.
- D. Close exposed ends of pipe and handrail by use of appropriate end cap.
- E. For posts set in concrete, furnish matching sleeves or inserts not less than 5 inches long.
- F. Locate intermediate rails equally spaced between top rail and finished floor or center line of tread.
- G. Verify dimensions on site prior to shop fabrication.

## **PART 3 - EXECUTION**

### 3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Notify the Construction Manager and Architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- C. Correct conditions detrimental to timely and proper complete of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

### 3.02 PREPARATION

Supply items to be cast in concrete.

### 3.03 INSTALLATION

- A. Install in accordance with shop drawings and manufacturer's instructions at locations indicated on the drawings.
- B. Erect work square and level, horizontal or parallel to rake of steps or ramp, rigid, and free from distortion or defects detrimental to appearance or performance.
- C. Expansion joints shall be provided as needed to allow for thermal expansion or contraction.

3.04 CLEANING

- A. As installation is completed, wash thoroughly using clean water and soap; rinse with clean water.
- B. Do not use acid solution, steel wool or other harsh abrasives.
- C. If stain remains after washing, remove finish and restore in accordance with NAAMM/NOMMA Metal Finishes Manual.

3.05 REPAIR OF DEFECTIVE WORK

- A. Remove stained or otherwise defective work and replace with material that meets specification requirements.
- B. Repair damaged finish as directed by Architect
- C. Replace defective or damaged components as directed by Architect.

**END OF SECTION**

## SECTION 05 70 00

### DECORATIVE METAL

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all decorative metal as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

Manufacturer shall have a minimum of 5 years' experience in manufacturing decorative metals for commercial use.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Provide shop drawings indicating quantities, dimensions, finishes, and attachment details.
- C. Provide product literature and samples for each color, pattern, and finish as indicated.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the project site in manufacturer's original packaging, properly labeled for identification and installation purposes.
- B. Store in location to avoid damage from job-site traffic, direct sunlight, moisture, stacking or other job-site contaminants. Store in a completely supported flat position. Edge storage is not recommended.
- C. Handle components to avoid denting or scratching of finished surfaces.
- D. DO NOT use markers on protective PVC film. Some types of ink will permeate the film and mark the material surface.

##### 1.08 PROJECT CONDITIONS

- A. Maintain a constant temperature range of 65°F to 85°F (18°C to 24°C), with stable relative humidity, for at least 48 hours prior to, throughout the installation period and maintained consistently thereafter.
- B. Installation locations must be enclosed, weatherproofed and climate controlled prior to commencing installation.
- C. Do not install if relative humidity is greater than 80%.

##### 1.09 WARRANTY

Provide manufacturer's warranty against defects in material and workmanship.

## **PART 2 – PRODUCTS**

### **2.01 MANUFACTURER**

- A. Basis of Design Manufacturer: Móz Designs, Inc., 711 Kevin Court, Oakland, CA 94621; Phone 510-632-0853; Fax 510-632-0852; Email: estimating@mozdesigns.com

### **2.02 METALS**

- A. Engravings Aluminum 'Moz Metals'
  - 1. .090" thick Aluminum: Type 5052 alloy complying with ASTM B209
  - 2. Sizes: 4'x8' and 4'x10' standard sizes
  - 3. Pattern Name: Circuit Engravings
  - 4. Color Name: Dark Grey Metallic
  - 5. Finish: Powder coat

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine product, substrates and installation conditions.
- B. Notify the contractor and architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- C. Do not proceed with work until conditions have been corrected.

### **3.02 SURFACE PREPARATION**

- A. Prior to installation, clean surface to remove dirt, debris and loose particles. Perform additional preparation procedures as required per the manufacturer's instructions.
- B. Protection: Take all necessary precautions to prevent damage to materials during installation.

### **3.03 INSTALLATION**

- A. Install the work of this section in strict accordance with manufactures written Technical Information and workability guidelines

### **3.04 CLEANING**

- A. Remove protective coverings and clean decorative metal to remove adhesives and tape residue. Test all solvents on non-exposed surfaces prior to use.
  - 1. For painted surfaces, use a mild detergent solution on a soft cloth.
  - 2. For stainless steel, use a glass cleaner and a soft cloth.
  - 3. For other surfaces, contact manufacturer for proper cleaning procedures.
  - 4. For HEAVY CLEANING and removal of grease, use oil based mineral spirits or naphtha. Low concentration ammonia-based cleaning agents such as glass cleaners may also be used.
  - 5. Minor scuffs can be polished out by hand with a #6 to #9 type finishing polish or wax.
  - 6. DO NOT treat with rubbing compounds or lacquer thinner as this may dissolve or etch the coating.
- B. Visually inspect all exposed surfaces for scratches or blemishes.
- C. Protect Decorative Metal from damage during remainder of construction period.

## **END OF SECTION**

SECTION 06 10 00  
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. The requirements of Division I apply to all Work of this Section.

1.02 SCOPE

- A. Provide all labor, materials, tools, facilities and equipment required for the fabrication and installation of rough carpentry and associated items (except that which is specified elsewhere) indicated on Drawings and necessary to complete the Work. Items include, but are not necessarily limited to, the following:
1. Blocking, backing, stripping, furring, and nailers.
  2. Rough hardware.
  3. Wood framing.
  4. Wood sheathing.
  5. Preservative treatment.
  6. Drilling, saw cuts, knock-outs and framing for ventilation.
  7. Wood sheathing backing at tile walls.

1.03 RELATED WORK (See also Table of Contents)

- A. Concrete Formwork: Section 03 10 00.
- B. Cast-in-Place Concrete: Section 03 30 00.
- C. Structural Steel: Section 05 12 00.

1.04 QUALITY ASSURANCE

- A. General:
1. Coordinate the work of all trades to ensure proper placement of all materials, anchors, etc., as well as providing for openings and anchors for the installation of surface mounted materials and equipment.
  2. Qualifications for Workmen: Provide sufficient skilled workmen and supervisors who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of construction involved and the materials and techniques specified.
  3. Rejection: In the acceptance or rejection of rough carpentry, no allowance will be made for lack of skill on the part of the workmen.
- B. Standards and References: (Latest Edition unless otherwise noted)
1. 2019 California Building Code (CBC).
  2. 2018 National Design Specification for Wood Construction (NDS)
  3. 2015 Special Design Provisions for Wind & Seismic (SDPWS)
  4. Lumber: West Coast Lumber Inspection Bureau (WCLIB); Standard Grading Rules for West Coast Lumber No. 17.
  5. Lumber: Western Wood Products Association (WWPA); Western Lumber Grading Rules 05.
  6. Redwood: Redwood Inspection Service (RIS); Standard Specifications for Grades of California Redwood Lumber.
  7. Wood Sheathing: The Engineered Wood Association; Specifications and Grades.
    - a. Structural Plywood: United States Product Standard PS1, Group 1 Douglas Fir.



- b. APA rated sheathing: United States Product Standard PS2.
  - 8. Wood Preservative: American Wood-Preservers' Association (AWPA):
    - a. U1, Use Category System: User Specification for Treated Wood.
    - b. M4, Standard for the Care of Preservative-Treated Wood Products.
- C. Submittals: (Submit under provisions of Section 01 33 00)
  - 1. Certification:
    - a. Preservative Treated Wood: Certification for waterborne preservative and that moisture content was reduced to 19 percent maximum, after treatment.
- D. Tests and Inspections:
  - 1. A testing program is required prior to start of construction. Testing program to be done in Compliance with the CBC requirements and in collaboration with Testing Laboratory, Design team, contractor, owner and submitted for review by the agency in charge of building enforcement. Requirements below are minimum requirements; additional requirements may be required in final testing program.
  - 2. If indicated on the Structural Drawings, load test expansion and epoxy anchors as indicated on the drawings.

#### 1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protection:
  - 1. After delivery, store all materials off the ground, covered, and in such a manner as to ensure proper ventilation and drainage and to protect against damage and the weather. Maintain wood at the maximum moisture levels indicated in Materials Section.
  - 2. Keep all material clearly identified with all grade marks legible; keep all damaged material clearly identified as damaged, and separately store to prevent its inadvertent use. Do not allow installation of damaged or otherwise non-complying material.
  - 3. Use all means necessary to protect the installed work and materials of all other trades.
  - 4. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Sawn Lumber:
  - 1. Lumber (Wood Framing): Meet requirements of following minimum grades. All grades to WCLIB Grading Rules No. 17. Species shall be Douglas Fir - Larch

<u>Item</u>	<u>Sizes</u>	<u>Grade</u>	<u>Maximum Moisture Content at Initial Use</u>	<u>Notes</u>
All Material	2x	No. 2	19%	Unless Noted Otherwise
All Material	3x,4x	No. 2	30%	Unless Noted Otherwise
All Material	6x	No. 1	30%	Unless Noted Otherwise
Decking	2x	Select Dex	19%	

- 2. "At initial use" shall be that point at which nails, screws, bolts, split rings, shear plates or other fasteners or the holes for said fasteners are placed in the wood.
- 3. All sawn lumber is assumed to be enclosed in the dry building envelope in the final service condition, unless noted otherwise, and free to dry to moisture content less than 19%.
- 4. The Contractor shall use whatever means necessary, including site drying to ensure that the moisture contents above are not exceeded.

5. All studs, plates, joists, rafters and beams 3x and thicker shall be free of heart center in accordance with the specified grading standards.
- B. Wood Sheathing:
1. Roof and Wall Structural Sheathing: PS1 and PS2 APA rated sheathing with exterior glue. Thickness type and grade shall be as indicated on Drawings.
  2. Where indicated on the Architectural Drawings as interior wall backing behind tile and in all toilet rooms behind sheet rock, to be C-C APA rated sheathing with exterior glue. Thickness shall be 5/8-inch at all locations.
  3. Flooring: C-C APA Performance rated tongue and groove with exterior glue. Thickness type and grade shall be as indicated on the Drawings.
- C. Building Paper: Fed. Spec. UU-B-790a, Type I, Grade B (15 lb. min. unless noted elsewhere.).
- D. Rough Hardware Fastenings and Connections: All types including bolts, lag screws, nails, spikes, screws, washers and other rough hardware, of kinds that may be purchased and that require no further fabrication, shall be furnished and installed for all finish and rough carpentry and shall conform to NDS Standards and dimensions. All hardware exposed to weather shall be hot-dipped galvanized per ASTM A153 Standards. All nails used into pressure treated lumber shall be hot-dipped galvanized per ASTM A153 or stainless steel.
1. Common wire nails or spikes shall be used unless noted otherwise on the Drawings. Box nails and sinker nails are not permitted. Vinyl coating is permitted on nails when not exposed to weather. Nails and staples shall conform to requirements of CBC Section 2303.6.
  2. Bolts: Bolt material shall conform to ASTM A307, Grade A. Bolt dimensions shall conform to ANSI/ASME B18.2.1 with hex head of sizes indicated.
  3. Lag Screws: Lag screws shall conform to ASTM 307, Grade A. All lag screws shall have hex heads where exposed.
  4. Washers: Standard flat washers shall conform to ANSI B18.22.1, Type A, Wide Pattern. Steel plate washers shall be Simpson BP or BPS or equivalent. Malleable iron washers shall be standard malleable iron washers.
  5. Power-Actuated Fasteners: Tempered steel pins with special corrosive resistant plating or coating. Pins shall have guide washers to accurately control penetration. Fastening shall be accomplished by low-velocity piston-driven power activated tool. Pins and tool shall be as manufactured by Hilti Fastening Systems or equivalent. See Drawings for size, type and embedment.
  6. Expansion Anchors: See Section 03 30 00 for anchors to concrete and Section 04 20 00 for anchors to masonry.
  7. Adhesive Anchors: See Section 03 30 00 for anchors to concrete and Section 04 20 00 for anchors to masonry.
  8. Fabricated Metal Timber Framing Connectors: Connectors shall be punched for nailing and bolting. Nails and nailing shall conform to the manufacturer's instructions with a nail provided for each punched hole. All connectors must have specific ICC approval. Types as noted on Drawings are Simpson Strong-Tie. Hardware suppliers other than Simpson shall submit a comparative material list itemizing product designation, load rating and supported member size for review by the enforcement agency and the Structural Engineer.

## 2.02 FABRICATION

- A. Lumber:
1. All lumber shall be air or kiln-dried to the maximum moisture content indicated in Materials Section.
  2. Furnish S4S unless otherwise noted.

3. Size to conform to rules of governing standard. Sizes shown are nominal unless otherwise noted.
- B. Wood Treatment:
1. Preservative Treatment: The treating process and results thereof shall conform to the appropriate AWWPA Standards for exterior, above ground use (3B) and as indicated in CBC Section 2303.1.9.
  2. After treatment and prior to shipping, air or kiln-dry lumber to maximum 19 percent moisture content.
  3. All treated wood shall be identified with a label meeting the requirements of CBC Section 2303.1.9.1.
  4. The amount of preservative to be injected into the wood shall be as required by the AWWPA standard for each type of installation.
  5. All wood in contact with concrete or masonry shall be preservative treated.
  6. Cut surfaces and bored holes in pressure treated wood shall be protected in accordance with AWWPA Standard M4.
- C. Fire Treatment: All fire-retardant-treated wood shall be identified with a label meeting the requirements of CBC Section 2303.2.4. The treating process and results thereof shall meet the requirements of CBC Section 2303.2. Moisture content of fire-retardant-treated wood shall meet CBC Section 2303.2.8. Treater shall submit design and fastener values for treated wood to Structural Engineer for review. See Drawings for location of fire-retardant-treated wood.

## 2.03 SOURCE QUALITY CONTROL

- A. Grade Mark each piece of lumber. Marking must be done by recognized agency.
1. Douglas Fir shall bear WCLIB or WWPA grade stamp.
  2. Pressure treated Douglas Fir shall bear AWWPA Quality mark.
- B. Wood Sheathing: Each panel shall be legibly identified as to type, grade and specie by APA grade. If plies are spliced, the slope of the scarf shall not be steeper than 1:8. White pockets will not be permitted in face plies.

## PART 3 - EXECUTION

### 3.01 SURFACE CONDITIONS

- A. Inspection:
1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly proceed.
  2. Verify that rough carpentry may be performed in strict accordance with the original design and all pertinent codes and regulations.
- B. Discrepancies: In the event of discrepancy, immediately notify Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

### 3.02 WORKMANSHIP

- A. General: All rough carpentry shall produce joints true, tight, and well nailed with all members assembled in accordance with the Drawings and with all pertinent codes and regulations.
- B. Selection of Lumber Pieces: Carefully select all members. Select individual pieces so that knots and obvious defects will not interfere with placing bolts or proper nailing or making

proper connections. Cut out and discard all defects which will render a piece unable to serve its intended function.

- C. Lumber may be rejected by the Architect, whether or not it has been installed, for excessive warp, twist, bow, crook, mildew, fungus, or mold, as well as for improper cutting and fitting.
- D. Shimming: do not shim any framing component.
- E. Care shall be taken that notching and boring of members is in strict conformance with the Drawings and that there are no over-cuts.

### 3.03 FASTENING

- A. Nailing: Except as otherwise indicated on Drawings or specified, all nailing shall be as required by CBC Table 2304.10.1 - Fastening Schedule.
  - 1. Nails or Spikes shall be common wire unless noted otherwise. Penetration of nails or spikes shall be one-half the length of the nail or spike into the piece receiving the point. However, to connect pieces 2" in thickness, 16d nails shall be used unless noted otherwise.
    - a. Bore holes for nails wherever necessary to prevent splitting.
    - b. Use finish or casing for finish work.
    - c. Use of machine nailing is subject to a satisfactory installation of nails. Minimum edge distances shall be maintained. Nails installed through sheathing with nail guns shall not penetrate into the outer plies deeper than hand nailing. Submittal of guns and nails is required.
    - d. All nailing into Pressure-Treated lumber shall utilize hot-dipped zinc coated galvanized nails or stainless steel nails per CBC Section 2304.10.5.
- B. Bolts and Lag Screws: Bolts shall be sizes indicated on Drawings. Holes for bolts shall be 1/16-inch larger than the bolt diameter. Malleable, Steel plate or standard flat washers shall be used where heads or nuts would otherwise bear directly on wood surfaces. Malleable or plate washers shall be used on all anchor bolts. Cut washers are not permitted. Lag screws shall be screwed (not driven) into place. For the shank, holes shall be bored the same depth and diameter as shank. For threaded portion, holes shall be pre-drilled as follows:

Lag Screw Size	Thread Portion Pre-Drill
1/2" diameter	1/4" diameter
5/8" diameter	5/16" diameter
3/4" diameter	3/8" diameter
7/8" diameter	1/2" diameter
1" diameter	5/8" diameter

Soap Lag screws prior to installation. Tighten all bolts and screws before closing in.

- C. Framing Devices: Install according to the manufacturer's instructions unless otherwise noted.

### 3.04 FRAMING AND ROUGH CARPENTRY

- A. Sills: Shall be in long lengths of sizes shown, fastened with anchor bolts as indicated, a minimum of two anchor bolts per piece. Place steel plate washers (but not standard flat or malleable iron washers) under nuts bearing on wood. Set sills level and true.
- B. Studs, Posts and Columns: Shall be full length. Corners shall be as detailed. Partitions or walls containing plumbing, heating or other piping shall be so formed as to give proper clearance for materials. Cut members as required to provide full bearing at ends. Connect to structure as indicated.

- C. Plates: Shall be full length of wall segment or 12-foot minimum and spliced as shown.
- D. Blocking: Blocking shall be same thickness and width of studs or joists unless shown otherwise. Blocking shall not be spaced over 8'-0" c.c. Install fire blocking in accordance with CBC. Horizontal fire blocking in walls shall be placed at floor lines and ceiling lines unless noted otherwise. Install blocking at all plywood joints where noted on the Drawings. Install wall width full height solid blocking at floor joists beneath all posts in walls. Blocking shall be installed around all wall, floor and roof penetrations.
- E. Joists and Beams: Shall be full span length and spliced over bearings unless shown otherwise. Install with crown side up. Beams or headers indicated to be built up of two or more joists shall be fabricated on the job using full length members. For two piece 2x members, stitch nail pieces together with 16d common nails spaced not over 12 inches c.c. and staggered. Clinch nails protruding through members. For three or more piece members, stitch bolt pieces together with ½" bolts spaced not over 12 inches c.c. and staggered.
1. Provide double joists and headers at all openings through roof unless otherwise shown on Drawings.
  2. Provide typical headers at all openings through walls where one or more studs are required to be cut. For penetration through walls narrower than stud spacing, provide solid blocking on all sides for fastening finish materials.
- F. Wood Sheathing: Install to pattern indicated and provide blocking at joints where noted on the Drawings. Center all joints over bearing supports. Nail to framing as indicated. Install wood sheathing with face plies perpendicular to joists unless indicated otherwise. Wall wood sheathing shall continue uninterrupted by ceilings or soffit from floor to floor or floor to roof unless specifically detailed on the Structural Drawings.
- G. Wood Furring, Stripping: Install as shown or required to provide nailing materials or passage of pipes, conduits, etc., not otherwise accommodated including ceiling stripping for gypsum drywall construction.
- H. Bridging: Space not over 8'-0" c.c. for spans over 16'-0". Joists 8 inches or less in depth shall not require bridging unless specifically indicated.
- I. Solid Wood Backing: Solid wood backing shall be provided for all wall and ceiling finishes and for supporting of mounted items for all trades, including but not limited to metal toilet partitions, toilet room accessories, frames, cabinets, casework, mirrors, trim, applied wall finishes, athletic equipment, food service equipment, piping, conduit, ducts, etc. Contractor shall coordinate placement of backing and supports with Subcontractor supplying mounted items.
- J. Building Paper: Install in all locations indicated except where included in other sections of the specifications.
- K. Cant Strips and Crickets: Shape to sizes shown. Rigidly fasten to construction. Form neat mitered corners.
- L. Wood Sheathing Backing: All toilet rooms, restrooms, single or joint occupancy shall have all walls backed with 5/8-inch thick wood sheathing with no surface voids. Install sheathing between the framing members and wallboard. The same wood sheathing shall also be provided and installed at all tile locations. At tile locations wood sheathing shall be installed between the framing members and the resin-cement backing board.

### 3.05 MISCELLANEOUS CARPENTRY WORK

- A. Install all items under other sections specified to be furnished and installed in other sections which relate to the rough carpentry work.
- B. Miscellaneous Carpentry Work not included under other sections but, indicated or required yet not specified elsewhere shall be furnished and installed hereunder, including appropriate fastening devices. Contractor shall provide miscellaneous carpentry work for all sections and divisions of work identified.
- C. Wood Curbs for Equipment: Construct all wood curbs for roof mounted equipment as detailed. Provide all miscellaneous blocking, bracing, supports, and other wood items as shown or required to complete the work.
- D. Plywood Backing for Electrical, telephone, and similar types of wall mounted equipment shall be provided hereunder where required. Plywood shall be 3/4-inch thick exterior A-C plywood with 'A' face exposed.
- E. Fire/Draft Stops: Construct fire and drafts stops in furred attic spaces where indicated or required by CBC code. Unless otherwise indicated on Drawings construct of not less than 5/8-inch Type 'X' gypsum wallboard or 1/2" wood sheathing, adequately supported by 2x4's at 24 inches c.c., braced diagonally to the roof structure. Draft stop and installation work shall conform to code requirements.
- F. Shoring and Bracing: Shore or brace for temporary support of all work as required during the construction period except any shoring and bracing specified and included under other sections of these specifications.
- G. Temporary Enclosures: Provide and maintain all barricades and enclosures required to protect the work in progress.
- H. Protect all work in progress and all work installed, as well as the work of all other trades. Any work damaged as a result of the work under this section shall be corrected to its original condition or replaced if directed by the Architect at no increase in cost to the Owner.
- J. Ventilation: Contractor shall include all labor and materials necessary to provide ventilation requirements of roof overhangs, eaves, attics, and all other components of the building required by codes to be ventilated. Work shall include removing knock-outs in wood I-joists for cross ventilation, drilling of blocking, wood sheathing, and other wooden components of the structure necessary to comply with requirements of the CBC for ventilation of buildings.

END OF SECTION 06 10 00

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## SECTION 06 20 00

### FINISH CARPENTRY

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract requirements and Division 1, General Conditions apply to this section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install complete Finish Carpentry Work as shown on Drawings and as specified herein. Provide hardware and attachment accessories as required for a complete and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. Verify all dimensions shown on Drawings by taking field measurements; proper fit and attachment of all parts is required.
- B. Following standards apply to Work of this Section except where more stringent requirements are specified herein.

- 1. Architectural Woodwork Institute "Quality Standards".
- 2. Western Wood Products Association Manual.
- 3. American Wood Preservers Association Specifications.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitutions Procedures.

##### 1.06 SUBMITTALS

- A. In accordance with Section 01 33 00 Submittal Procedures.
- B. Submit shop drawings of millwork at full size or large-scale showing sizes, materials, grain run, methods of construction, connection to adjacent members and installation. Indicate all backing members for installations and all hardware

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

Comply with the requirements of Section 01 55 00.

##### 1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

##### 1.10 WARRANTY

Provide Standard Warranty in accordance with Section 01 78 36 Warranties and Bonds.



## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. Douglas Fir: West Coast Lumber Inspection Bureau "Standard Grading and Dressing Rules" and Western Wood Products Association, graded "C" and better, flat grain grade marked by WCLIB or WWPA.
- B. Douglas Fir Plywood: U.S. Product Standard PS-1, American Plywood Association, grade trademarked "C-D", plugged, exterior glue, sanded.
- C. Blocking, Furring, etc.: Standard Grade Western White Pine, Construction grade Douglas Fir or other equally sound softwood, as graded by WCLIB or WWPA.
- D. Softwood Lumber: PS 20; custom grade in accordance with AWI maximum moisture content of 6%; of quality capable of transparent finish.
- E. Hardwood Lumber: FS MM-L-736; custom grade in accordance with AWI; maximum moisture content of 6% of quality capable of transparent finish.

### **2.02 ACCESSORIES**

- A. Nails, bolts, nuts, washers, blind fasteners, lags and screws, size and type to suit application.
- B. Wood Filler: oil base, tinted to match surface finish color.
- C. Shelf Standards and Rests: Knap and Vogt #255 & #256 for recessed application. Provide two hold down clips for each shelf in the slot above
- D. Closet Hanger Bars and Supports: Knap and Vogt #770, #660, #734, #735, and #1195. Provide intermediate support of spans over 6'-0".

### **2.03 SHOP TREATMENT OF WOOD MATERIALS**

- A. Shop pressure treat wood materials requiring UL fire rating or preservations.  
Provide UL approved identification on fire retardant treated material.
- B. Wood Preservative (PT type) Wolmanized, Pressure Treated Lumber, manufactured by Osmose Wood Products or approved equal.
- C. Fire Retardant (FR-S Type) chemically treated, and pressure impregnated, capable of providing a maximum rating of 25; manufactured by Demose Wood Products. Dricon FRT or approved equal.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that surfaces and openings are ready to receive work and field measurements are as shown on Shop Drawings and instructed by the fabricator.
- C. Verify that mechanical, electrical, and building items affecting work of this Section are placed and ready to receive this work.
- D. Correct conditions detrimental to timely and proper completion of the Work.
- E. Do not proceed until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of conditions.

### 3.02 PRIMING

Back paint all wood surfaces inaccessible and unexposed after installation before delivery with an approved linseed oil and aluminum primer.

- A. Prime coat all unfinished metal parts.
- B. Prime paint surfaces of items or assemblies to be in contact with cementitious materials.

### 3.03 FINISH CARPENTRY INSTALLATION

- A. Use only hot dip galvanized or aluminum finish or casting nails. Set nails for putty stopping in surface members. Hammer marks not acceptable on any exposed finished surface and may be cause rejection of Work by Architect.
- B. Make all end splices exposed in finished members bevel splices and not square butted. Install members in as long lengths as possible.
- C. Install Work to details shown, plumb, level and to line and securely anchored per AWI custom quality standard. Make scribes where required accurate. Miter corners of trim.
- D. Provide and install other miscellaneous millwork items and related Work required to complete Work of this Section.
- E. Prepare all woodwork installed hereunder by cleaning and sanding as required to receive finishes specified in Section "Painting and Finishing".
- F. Install all doors and frames; finish hardware and bathroom accessories per manufacturer's recommendation.
- G. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth and site finish.

**END OF SECTION**

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## SECTION 06 41 00

### ARCHITECTURAL CASEWORK

#### PART 1 – GENERAL

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract requirements and Division 1, General Conditions apply to this section.

##### 1.02 SCOPE OF WORK SUMMARY

###### A. Section Includes:

1. Plastic laminate casework
2. Plastic laminate countertops
3. Solid surface countertops
4. Hardware typically furnished by the casework manufacturer
5. Shelving
6. Structural supports incorporated into wood casework

###### B. Excluding:

1. Metal support brackets and fittings that are part of the building structure
2. Plumbing, electrical fixtures, and telephone equipment

###### C. Related sections:

1. Rough carpentry: Wood blocking or grounds inside finished walls or above finished ceilings
2. Plumbing: Fixtures and fittings installed in countertops

##### 1.03 STANDARDS AND REFERENCES

- A. The *North American Architectural Woodwork Standards (NAAWS)*, latest edition. Jointly published by Woodwork Institute and the Architectural Woodwork Manufacturers Association of Canada.
- B. NEMA LD-3, High Pressure Decorative Laminate, latest edition
- C. ANSI 208.1, Particle Board, latest edition
- D. ANSI 208.2, MDF, latest edition

##### 1.04 QUALITY ASSURANCE

A. Work shall be in accordance with the Grade or Grades specified of the *North American Architectural Woodwork Standards*.

###### B. Certified Compliance Program (CCP):

1. Before delivery to the job site, provide a Woodwork Institute Certified Compliance Certificate indicating the millwork and countertop products being supplied and certifying that these products fully meet the requirements of the NAAWS Grade or Grades specified.
2. Provide a Woodwork Institute Certified Compliance Label on each countertop and elevation of casework.

3. At completion of installation provide a Woodwork Institute Certified Compliance Certificate indicating the products installed, and certifying that the installation of these products fully meets the requirements of the NAAWS Grade or Grades specified.
4. All fees charged by the Woodwork Institute for its Certified Compliance program are the responsibility of the millwork manufacturer and/or installer and shall be included in their bid.

C. Qualification:

1. A Woodwork Institute Accredited Millwork Company in good standing
2. Firm (woodwork and countertop manufacturer) with no less than five years of production experience similar to a specific project, whose qualifications indicate the ability to comply with the requirements of this section.
3. The woodwork manufacturer must have at least one project in the past five years where the value of the woodwork was within 20 percent of the cost of woodwork for this project.

D. Single source responsibility: A single manufacturer shall provide and install the work of described in this section.

1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00 Submittal Procedures.

B. Shop drawings:

1. Submit shop drawings in conformance with the requirements of the *North American Architectural Woodwork Standards*.
2. Furnish a Woodwork Institute Certified Compliance Label on the first page of the shop drawings.
3. Submit two copies, one of which will be returned with reviewed notations. Make corrections noted (if any), and distribute required copies prior to the start of work.

C. Samples:

1. Submit four finished samples of each species and cut of wood to be used. Lumber samples to be minimum 6 inches by 18 inches, and sheet product samples to be minimum 12 inches square. Samples shall represent the range of color and grain expected to be provided.
2. Submit four unfinished samples of each product to be provided for job-site painting or finishing. Lumber samples to be minimum 6 inches by 18 inches, and sheet goods to be 12 inches square.
3. Submit a sample of each plastic laminate, and/or solid surface color and pattern to be used.

1.07 DELIVERY STORAGE AND HANDLING

- A. Coordinate fabrication, delivery, and installation with the general contractor and other applicable trades.
- B. Deliver materials only when the project is ready for installation and the general contractor has provided a clean storage area.
  1. Delivery of architectural millwork shall be made only when the area of operation is enclosed, all plaster and concrete work is dry and the area broom clean.

2. Maintain indoor temperature and humidity within the range to be expected after occupancy.

1.08 PROJECT CONDITIONS

Comply with the requirements of Section 01 50 00 Construction Facilities.

1.9 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties and Bonds.

**PART 2 – PRODUCTS**

2.01 MILLWORK COMPONENTS

- A. Lumber: In accordance with the *North American Architectural Woodwork Standards* Grade specified for the product being fabricated. Moisture Content: 6% to 12% for boards up to 2-inch (50.8 mm) nominal thickness, and shall not exceed 19% for thicker pieces.
- B. Core:
  1. MDF Grade 130 containing no added urea formaldehyde.
    - a. Water-resistant core, where required: Medium Density Fiberboard meeting the requirements of ANSI A208.2 Grade 130 MR-50.
- C. Veneer core plywood: A non-telegraphing hardwood manufactured with exterior glue.
- D. Plastic laminate: Meeting the requirements of the *North American Architectural Woodwork Standards* for its use.
  1. High pressure laminated plastic conforming to NEMA LP-3, 0.048-inch thickness for tops and 0.048-inch thickness for vertical surfaces.
  2. Low Pressure Melamine for exposed interior and semi-exposed surfaces.
  3. Backing sheet: LD-3-BK 20 backing grade undecorated plastic laminate.
- E. Edgeband: High-pressure decorative laminate of the same pattern and color as the exposed surfaces.
- F. Hardboard: PS-58, pressed wood fiber with resin binder, tempered grade, smooth two sides for drawer bottoms.
- G. Adhesives: Type II, water-resistant typical. Type I, fully waterproof at sink tops and sink cabinets.
- H. Hardware:
  1. Finish: Satin aluminum unless noted otherwise.
  2. Pulls: Amerock BP76312-G10 or Architect approved equal.
  3. Drawer guides for Drawers 24" wide or less: 100-pound capacity, full extension, ball bearing. Accuride 3832 or Architect approved equal.
  4. Drawer guides for File, Paper Storage and Heavy Duty Drawers 42" wide or less: 150-pound capacity, over travel extension, ball bearing. Accuride 4043 or Architect approved equal.
  5. Hinges: Concealed, European style, self-closing, Grade II hinges minimum 120 degree opening.
  6. Shelf supports: Knappe & Vogt KV 255 or Architect approved equal.
  7. Shelf clips: Knappe & Vogt KV 256 or Architect approved equal.

8. Locks: Provide on all doors and drawers unless noted otherwise in Drawings.
  - a. Door locks: Olympus Door Lock 100 series or Architect approved equal.
  - b. Drawer locks: Olympus Door Lock 200 series with re-keying feature or Architect approved equal.
9. Miscellaneous Accessories: Provide grommet(s) as indicated in the Drawings.

## 2.02 MILLWORK FABRICATION

- A. Grade: NAAWS Custom Grade.
- B. Exposed exterior surfaces: High-pressure decorative laminate Grade VGS. Color and pattern as indicated in the Drawings.
- C. Exposed interior (open cases) and semi-exposed (behind doors) interior surfaces: White melamine.
- D. Cabinet construction type: Frameless.
- E. Door Interface Style: Flush overlay
- F. Edgebanding at all exposed and semi-exposed edges including doors, drawer fronts and false fronts: High-pressure laminate of the same color and pattern as the exposed surfaces.
- G. Shelves: Adjustable shelves to be 1" thick.
- H. Doors and drawer fronts: High pressure laminate Grade VGS face, cabinet liner Grade CLS back.
- I. Drawer Boxes:
  1. Front and back: 1/2" particleboard with melamine surfacing.
  2. Sides: 1/2" Particle board with melamine surfacing
  3. Bottoms: 1/4" Hardboard
  4. Joinery: Dowels

## 2.03 COUNTERTOPS

- A. Grade: NAAWS Custom Grade
- B. Plastic Laminate
  1. Flat countertops: NEMA LD-3 Grade HGS. 0.048" thick.
  2. Formed countertops: NEMA LD-3 Grade HGP. 0.039" thick.
  3. Manufacturer, Pattern, Color: As indicated in the Drawings.
  4. Core: 3/4" Particleboard, composed of wood chips and waterproof resin binders at dry tops, 3/4" MDF MR-50 at sink tops.
  5. Backsplash detail: Cove, 4" high minimum
  6. Front edge: No-drip bullnose edge
  7. Cutouts: Seal edges of cutouts in sink countertops with a color-toned (for verification) water-resistant sealer before sinks are installed.
- C. Solid Surface
  1. Manufacturer, Pattern, Color: As indicated in the Drawings
  2. Backsplash detail: Cove, 4" high minimum.
  3. Front edge: No-drip bullnose edge

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Correct conditions detrimental to timely and proper completion of the Work.
- C. Do not proceed until unsatisfactory conditions are corrected.
- D. Beginning of installation means acceptance of conditions.
- E. Verify that surfaces and openings are ready to receive work and field measurements are as shown on Shop Drawings and instructed by the fabricator. Verify dimensions for work of other trades incorporated into the casework.
- F. Verify the adequacy and proper location of any required backing or support framing.
- G. Verify that mechanical, electrical, plumbing, and other building components affecting work in this section are in place and ready.

### **3.02 INSTALLATION**

- A. Install all work in conformance with the *North American Architectural Woodwork Standards*, latest edition.
  - 1. Installation shall conform to the *NAAWS* grade of the items being installed.
- B. All work shall be secured in place, square, plumb, and level.
- C. All work abutting other building components shall be properly scribed.
- D. Mechanical fasteners used at exposed and semi-exposed surfaces, excluding installation attachment screws and those securing cabinets end to end, shall be countersunk.
- E. Equipment cutouts shown on plans shall be cut by the installer.

### **3.03 ADJUSTING AND TOUCH UP**

- A. Before completing installation, the installer shall adjust all moving and operating parts to function smoothly and correctly.
- B. All nicks, chips, and scratches in the finish shall be filled and retouched. Damaged items that cannot be repaired shall be replaced.

### **3.04 CLEANUP**

- A. Upon completion of installation, the installer shall clean all installed items of pencil and ink marks and broom clean the area of operation, depositing debris in containers provided by the general contractor.

**END OF SECTION**



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## SECTION 06 60 00

### PLASTIC FABRICATIONS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

A. Provide factory-finished Surface Materials and similar items where shown on the drawings, as specified herein, and as needed for a complete and proper installation. Work may include, but is not limited to:

1. Standard Decorative Laminates.
2. Solid Surfacing.

##### 1.03 STANDARDS AND REFERENCES

- A. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
- B. ASTM G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- C. ISO 4586-2 - High Pressure Decorative Laminates; International Organization for Standardization.

##### 1.04 QUALITY ASSURANCE

Comply with the Standard requirements established by Manufacturer.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Samples:
1. Selection Samples: Submit actual samples of surfacing materials to illustrate full range of colors, patterns, and finishes available.
  2. Verification Samples: Submit two samples, each 12 inches square, illustrating each selected surfacing material in specified color, pattern, and finish.
- C. Manufacturer's Instructions:
1. Submit manufacturer's printed installation instructions for each product.
  2. Submit manufacturer's Safety Data Sheets (M.S.D.S.) for each adhesive.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00.
- B. Comply with Manufacturer's Standard Requirements.

##### 1.09 OPERATION AND MAINTENANCE DATA

Comply with the requirements of 01 77 00 Project Closeout.

## 1.10 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

## **PART 2 – PRODUCTS**

### 2.01 STANDARD DECORATIVE LAMINATES

- A. Acceptable Products: As indicated on the Drawings.
- B. Product Description: Decorative surface papers, impregnated with melamine resins, bonded under heat and pressure to kraft papers impregnated with phenolic resins.
- C. Standard Decorative Laminate – General Purpose Type: having the following physical characteristics:
  - 1. Sheet thickness: 0.048-inch (1.219 mm) plus/minus 0.005-inch (0.127 mm).
  - 2. Exceeding performance requirements of NEMA LD 3-1995 Grade HGS.
  - 3. Surface burning characteristics in accordance with ASTM E 84; unbonded: Flame spread 55; Smoke developed 30.
  - 4. Patterns and Finishes: Selected from manufacturer's full range of available selections, as selected and approved by Architect.

### 2.02 SOLID SURFACING MATERIAL

- A. Acceptable Product: As indicated on the Drawings.
- B. Product Description: Homogenous sheet material composed of acrylic resins, fire-retardant filler materials, and coloring agents.
  - 1. Nominal sheet thickness: 0.50 inch (13 mm).
  - 2. Surface burning characteristics in accordance with ASTM E 84: Flame spread less than 25; Smoke developed less than 25.
  - 3. Liquid Absorption, ISO 4586-2, for 1/2-inch material thickness: 0.4 percent after 2 hours boiling water.
- C. Izod Impact, ASTM D 256, Method A: 0.2 foot pounds per inch.
  - 1. Tensile Modulus, ASTM D 638 Nominal: 1.7 million pounds per square inch.
  - 2. Thermal Expansion, ASTM D 696: 0.000019-inch per inch per degree F, maximum.
  - 3. Hardness, ASTM D 2583, Barcol Impressor: 59.
  - 4. Flexural Modulus, ASTM D 790: 1.6 million pounds per square inch.
  - 5. Deflection Temperature under load, ASTM D 648: 90 degrees C.
  - 6. Stain Resistance: ANSI Z124.6 modified, Method 3.4: No effect.
  - 7. Boiling Water Resistance, NEMA LD 3-1995, Method 3.5: No effect.
  - 8. High Temperature Resistance: NEMA LD 3-1995, Method 3.6: No effect.
  - 9. Radiant Heat Resistance: NEMA LD 3-1995, Method 3.10: No effect.
  - 10. Light Resistance: NEMA LD 3-1995, Method 3.3: No effect.
  - 11. Ball Impact Resistance, NEMA LD 3-1995, Method 3.8, one half pound ball, unsupported: 125 inches.
  - 12. Specific Gravity: 0.977 ounces per cubic inch (1.69 grams per cubic centimeter).
  - 13. Approximate weight: 4.2 pounds per square foot (20.5 kg/square m).

14. Weatherability: ASTM D 2565: Pass.
15. Fungus Resistance, ASTM G 21: Pass.
16. Bacterial Resistance, ASTM G 22: Pass.
17. Pittsburgh Protocol Toxicity: 66.9 grams.
18. Patterns and Finishes: Selected from manufacturer's full range of available selections, selected and approved by Architect.
19. Impact Resistance NEMA LD3-1995 (1/2 lb. Ball) SSV bonded to substrate\*\*\* Method 3.08 modified. 125" (No Failure)
20. Tensile Toughness ASTM D 638. 21 (in. – lb./in. <sup>3</sup>)
21. Tensile Modulus ASTM D 638 Nominal.  $1.7 \times 10^{-5}$  lb./in.<sup>3</sup>
22. Density 1.60 gram/cm<sup>3</sup>
23. Approximate weight 4.2 lbs./ft<sup>2</sup>
24. Pittsburgh Protocol Toxicity = 30 grams range

### **PART 3 – EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that specified items may be installed in accordance with the approved design.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

#### **3.02 PREPARATION**

Surface preparation: Precondition surfacing materials and surfaces to receive surfacing materials in accordance with manufacturer's printed installation instructions.

#### **3.03 APPLICATION**

Install materials in accordance with manufacturer's printed instructions.

**END OF SECTION**

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## SECTION 07 05 00

### CONCRETE FLOOR TESTING

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Administrative and procedural requirements for testing interior concrete slabs for moisture vapor emission rate, alkalinity, and temperature and humidity.
- B. Testing shall be conducted by the Owner's Testing Agency.

##### 1.03 STANDARDS AND REFERENCES

- A. ASTM F-1869 Standard Test Method for Measuring Vapor Emission Rate of Concrete Subfloor using Anhydrous Calcium Chloride.
- B. ASTM F-710 Standard Practice for Preparing Concrete Floors and other Monolithic Floors to receive Resilient Flooring
- C. ASTM F-2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

##### 1.04 QUALITY ASSURANCE

- A. Owner Responsibilities: Owner will engage a qualified testing agency to perform testing indicated.
  - 1. Owner will furnish Construction Manager with name, address, and telephone number of testing agency.
  - 2. Payment for testing services will be made by the Owner directly to the testing agency.
    - a. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be paid by the Owner and charged to Contractor by an adjustment to the Contract Sum through a Change Order.
- B. Testing Agency Responsibilities: Cooperate with Architect, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
  - 1. Notify Architect, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  - 2. Determine the location from which test samples will be taken.
  - 3. Perform tests and submit a certified written report of each test, inspection, and similar quality-control service to Owner, Architect, Construction Manager and Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  - 4. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  - 5. Do not perform any duties of Contractor.

C. Contractor Responsibilities: Coordinate sequence of activities to accommodate required testing services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities. Notify agency sufficiently in advance of operations to permit assignment of personnel.
2. Acclimate enclosed spaces to the anticipated occupied temperature and humidity as required by the manufacturer of the specified flooring material(s) and in accordance with ASTM testing requirements.
3. Cooperate with agencies performing required tests and inspections, provide reasonable auxiliary services as requested. Provide the following:
  - a. Access to the Work.
  - b. Incidental labor and facilities necessary to facilitate tests and inspections.
  - c. Security and protection for testing and inspecting equipment at Project site.
4. Project Meeting: Schedule and conduct project meeting not less than 30 days prior to flooring installation to discuss testing requirements, specifications and locations prior to testing. Attendees shall include Owner, Architect, Construction Manager, Contractor, Testing Agency, and adhered floor installer representatives.

#### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

#### 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00 Submittal Procedures.

B. Reports: Reports of results of all testing shall be submitted by the Owner's Testing Agency. Reports shall include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. For each test provide a record of interior temperature, humidity, moisture vapor emission, in-concrete relative humidity and alkalinity results for testing period.
8. Test and inspection results and an interpretation of test results.
9. Provide on the Architectural Floor Plan(s) as furnished by the Architect a test number identifying each test conducted.
10. Name and signature of laboratory inspector.
11. Recommendations on retesting and re-inspecting.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with Section 01 66 00 Product Storage and Handling Requirements.

#### 1.08 PROJECT CONDITIONS

Comply with the requirements of Section 01 50 00.

1.09 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 - PRODUCTS**

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment to be provided by Testing Agency.
- B. American Moisture Test, Inc., Website: americanmoisturetest.com, Tel: (866) 670-9700.
  - 1. ASTM F1869 Moisture Vapor Emission Test kits
  - 2. ASTM F-2170 In-Concrete Relative Humidity Testing System
  - 3. ASTM F-710 Alkalinity-pH wide range 1 – 14pH meter

**PART 3 - EXECUTION**

3.01 EXAMINATION

Site: Weatherproofed, doors installed and windows secured. Do not start testing process when site has standing water, surface contaminants, exposed to exterior conditions or concrete installation is less than 90 days of age.

3.02 PREPARATION

- A. Contractor Responsibilities:
  - 1. Preparation of Substrates:
    - a. Prepare concrete substrates according to ASTM requirements.
    - b. Verify that substrates are dry and free of curing compounds, sealers, and hardeners for vapor emission testing per ASTM F-1869.
    - c. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
  - 2. Temperature and Humidity: Maintain site at the temperature and humidity conditions to those anticipated during normal occupancy and maintain these conditions 48 hours prior and during testing period. If meeting this criteria is not possible, then minimum conditions should be 75± 10°F and 50± 10% relative humidity.
    - a. When a building is not under HVAC control, record temperature and humidity at start and end of testing using a portable data logging system.

3.03 TESTING

- A. Testing: Testing Agency shall perform tests as follows:
  - 1. Water vapor emission testing, ASTM F 1869.
    - a. Perform all gram scale weights on site.
    - b. Expose dome for 60 to 72 hours.
    - c. Report results as pounds of emission per 24 hours per ASTM F-1869.
    - d. Perform subfloor moisture testing in accordance with the Manufacturer's requirements for each floor system type. Do not proceed with flooring installation until results of moisture tests are acceptable. All test results shall be documented and retained



2. In-Concrete Relative humidity testing, ASTM F 2170.

- a. Satisfactory results shall have a maximum 75 percent relative humidity level measurement.

3. Alkalinity Testing:

- a. Apply neutral-pH solution to form a 1-inch diameter circle directly to interior of moisture dome.
- b. Allow to absorb into concrete for 1 minute.
- c. Apply flat tip pH meter to solution and document result as required by manufacturer.
- d. Perform pH tests on concrete floors regardless of their age or grade level in accordance with the Manufacturer's requirements for each floor system type. PH level shall not exceed range of the Manufacturer's requirements for each floor system type. All test results shall be documented and retained

B. Adhered floor coverings shall not be installed in areas where satisfactory test results have not been obtained.

C. Consult Architect on remedial measures to reduce concrete levels prior to installing flooring. Installation of flooring deems acceptance of on-site conditions for a warranted application.

3.04 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
- B. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."
- C. Protect construction exposed by or for quality-control service activities.
- D. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

**END OF SECTION**

## SECTION 07 10 00

### DAMPROOFING AND WATERPROOFING

#### **PART 1 -- GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract requirements and Division 1, General Conditions apply to this section.

##### 1.02 SCOPE OF WORK SUMMARY

Work included: Provide and install membrane waterproofing where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. This Contractor shall examine all surfaces before commencing work to see that they are in proper condition to receive his work. All surfaces shall be dry, smooth and clean. The Contractor shall immediately notify the Architect, in writing, of any defective work by others that might prevent him from properly performing his work in a first-class manner in accordance with these Specifications. He shall not proceed with any work until such defects are remedied and work approved by the Architect. This Contractor shall apply his work during normal working hours so that the project manager may have the opportunity to oversee the actual operation.
- B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- C. The Contractor shall see that all sleeves, metal work, flashings and counter flashings, to be furnished and/or installed under other divisions of the Specifications, are properly installed and assume full responsibility for the water-tightness of all such work.
- D. Guarantee: Written guarantee is required from the applicator, guaranteeing this work against defective workmanship for a period of two years from date which the Owner records the Notice of Completion.
- E. Certification: Upon completion, issue to the Architect a Certificate of Inspection and Compliance indicating that the completed work meets all the requirements of these Specifications and the manufacturer's printed instructions.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. In accordance with Section 01 33 00 Submittal Procedures.
- B. Product data: Within 35 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
  - 1. Materials list of items proposed to be provided under this Section;
  - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
  - 3. Manufacturer's recommended installation procedures which, when accepted by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.

C. Provide approved written guarantee per system specified; refer to Application Specification of manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

Comply with Section 01 66 00 Product Storage and Handling Requirements.

1.08 PROJECT CONDITIONS

Comply with the requirements of Section 01 50 00.

1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

1.10 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 - PRODUCTS**

2.01 MATERIALS

A. Membrane or membrane assemblies for concrete walls behind berms shall be such as to provide a watertight condition for the life of the building and shall be a waterproofing Contractor approved by the manufacturer as manufactured by GCP Advanced Technologies. System shall apply Bituthene Waterproofing System 3000.

1. Bituthene 3000 Waterproofing Membrane is a factory-made composite product with a minimum thickness of 60 mils (1.5 mm). It consists of 56 mils (1.4 mm) of rubberized asphalt and 4 mils (0.1 mm) of cross-laminated polyethylene film. Bituthene 3000 is supplied in rolls 36" (0.9m) wide and 60' (18.3 m) long. The rubberized asphalt is covered with release paper that is removed during installation. The membrane is self-adhesive and cold applied. No special adhesive or equipment is necessary to form laps.
2. Physical Properties - Bituthene Liquid Membrane LM-3000:

Property:	Typical Value:	Test Method:
Solids Content	100%	ASTM D-1644
Elongation	250%	ASTM D-412
Peel Adhesion	5 lb./inch width	See footnote 1
Pliability (180° bend over 1" mandrel)	Unaffected at -25°F	ASTM D-146
Hydrostatic head	75 ft. min.	See footnote 2

Footnotes:

1. Liquid Membrane is applied to dry concrete blocks and cured for 7 days. Membrane is then peeled from the concrete blocks at a 90° angle.
2. Hydrostatic head tests are performed by applying liquid membrane on primed concrete, then sealing the waterproofed concrete to a pressure chamber. Water is introduced under pressure equivalent to 75 head feet.
3. Elastomeric membrane 3000 and 3100:

Property:	Typical Value:	Test Method:
Color	Dark gray-black	
Pliability	Unaffected at -25°F (-	ASTM D-146

Property:	Typical Value:	Test Method:
(180° bend over 1" mandrel)	32°C)	
Tensile strength: membrane	250 (psi) minimum	ASTM D-412
Tensile strength: film	4000 (psi) minimum	ASTM D-412 (Die C) modified
Elongation - ultimate failure of rubberized asphalt (%)	300 minimum	ASTM D-412 (Die C) modified
Cycling over crack	No effect after 100 cycles at 15°F (-26°C)	See footnote 1
Cycle over 1" joint	No effect after 1000 cycles at 15°F (-26°C)	See footnote 1
Puncture resistance-Bituthene Membrane (lb.)(stretched by blunt object)	40 minimum	ASTM E154
Puncture resistance: Polyethylene film	250 minimum (in. oz. tear)	ASTM D781 (Impact from sharp object)
Peel Adhesion	(Lb./in. width)	
Resistance to hydrostatic head	150 ft. of water minimum	See footnote 2
Exposure to fungi in soil 16 wks	Unaffected	GSA-PBS 07111
Permeance-perms	0.1 Maximum 0.2 (Grains/sq.ft./in.Hg)	ASTM E-96 Method B
Water Absorption: 72 hrs	0.25 maximum (% By weight)	ASTM D-1228

Footnotes:

1. Membrane is applied across two primed blocks with no separation between blocks. At -15°F. blocks are pulled apart to 1/4", then returned to original position. Cycle is repeated 100 times. For joint cycling, the blocks are double covered with membrane, separated by 1", then cycled at -15°F between 3/4" and 1 1/4" a minimum of 1000 cycles.
  2. Hydrostatic head tests are performed by applying membrane on primed concrete, then sealing the waterproofed concrete to a pressure chamber. Water is introduced to 150 head feet.
- B. Bituthene Primer P-3000 is a rubber-based primer in solvent specifically formulated to provide good initial adhesion and excellent permanent adhesion of Bituthene Waterproofing Membranes.
- C. Bituthene Elastomeric Mastic EM-3000 is rubberized asphalt base mastic.
- D. Bituthene Liquid Membrane LM-3000 is a two-component, elastomeric cold-applied mastic grade material.
- E. Bituthene Protection Board PB-3000 is lightweight, expanded polystyrene having a nominal density of 1.0 lb./cu. ft.

1. Bituthene PB-3000 shall have the following physical properties:

Property:	Typical Value:	Test Method:
Nominal Density	1.0 lb./cu. ft.	
Thermal Conductivity K factor (BTU/Hr./Sq. Ft./F.In.)	.24 @ 40°F .26 @ 75°F	ASTM C-177
Thermal Resistance (R-Value)	1" thickness = 4 3/4" thickness = 3	ASTM C-177

- F. Bituthene Protection Board Adhesive PBA-3000 is a fast drying, rubber-based cement.

- G. All materials shall be furnished by the manufacturer whose specification is used to the extent of his standard and/or stock materials. Materials unable to be furnished by the manufacturer shall meet his reference specification requirements.
1. Contractor shall furnish a statement signed by the manufacturer or his authorized representative that the materials to be supplied are proper for the use indicated and that the manufacturer is in agreement with the Contractor's use of these material systems as they are applicable to this installation.
  2. All materials shall be delivered to the site in the original unbroken manufacturer's wrapping material with the original labels thereon.

### **PART 3 – EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Notify the Construction Manager and Architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

#### **3.02 PREPARATION**

- A. Verify that surfaces are solid, free of frozen matter, loose particles, cracks, pits, rough projections, and foreign matter detrimental to adhesion and application of waterproofing.
- B. Do not apply waterproofing to damp, frozen, dirty, dusty, or deck surfaces unacceptable to manufacturer.
- C. The surface shall be inspected by a representative of the coatings manufacturer and by the waterproofing Contractor. A written notice to the prime Contractor shall be provided to indicate any substrate deficiencies that must be corrected prior to application of the waterproofing coatings. The start of the application work shall not commence until acceptance of the surface by the waterproofing Contractor and the representative of the manufacturer.
- D. Surface preparation: A smooth monolithic concrete surface is required. A broom surface is not acceptable. The concrete surface shall be dry, frost free, clean and cured a minimum of seven days prior to the application. The primer and membrane surface shall be free of voids, spalled areas, sharp projections, loose aggregate, and form release agents. Concrete curing compounds containing oil, wax or pigments shall not be used. Form release agents shall be the self-dissipating type that will not transfer to the concrete. Any surface defects such as cracks, holes or cavities shall be filled and finished flush with a Portland cement grout or concrete. Top surfaces of projecting ledges, below grade, except footings, shall be finished to a steep bevel with Portland cement mortar. Smooth concrete block walls shall be protected with membranes by striking off joints flush with surface.

#### **3.03 INSTALLATION**

- A. Foundation Walls and Vertical Surfaces
  1. General: The membrane, when in place, must withstand a minimum static ground water pressure of 150 feet (46 m).
  2. Priming: Application of primer shall be limited to what can be covered by Bituthene Waterproofing Membrane in a given workday. Primed areas not covered by membrane during the workday will be re-primed. Apply primer by spray, roller or brush at a rate of

250-350 square feet per gallon. Roller should be a natural material such as lamb's wool, having a nap of approximately one inch. Primer shall be applied to a clean, dry, frost-free and dust-free surface. Sufficient primer must be used on the dry surface to condition it to a dust-free state suitable for the application of Bituthene Waterproofing Membranes. Coverage of primer will vary due to the texture and porosity of the surface to receive the primer.

- a. Bituthene Primer P-3000 should not be applied below 40°F (5°C) on vertical surfaces. At temperatures below 40°F (5°C), Bituthene P-3100 Primer must be used and it may be used up to 90°F (32°C). Allow P-3000 to dry one hour or until tack-free. Allow P-3100 to dry 30 minutes.
3. Membrane Installation: Apply Bituthene Waterproofing Membrane vertically in sections of 8 feet in length or less. On higher walls apply two or more sections with the upper overlapping the lower by at least 2-1/2" (64 mm). Press all membrane in place with heavy hand pressure or rollers during application. Two piles of Bituthene Membrane are recommended for below grade or earth shelter applications on any wood surfaces.
4. Sealing Edges: Bituthene Waterproofing Membrane shall be applied over the edge of the slab or over the top of the foundation or parapet wall. If the membranes are terminated on the vertical surface, a reglet or counter flashing may be used or the membrane may be terminated directly on the vertical surface by pressing very firmly to the wall. Press the edges with a metal or hardwood tool such as a hammer or knife handle. Apply a troweled bead of Bituthene EM-3000 to all vertical and horizontal terminations. Bituthene Liquid Membrane LM-3000 can be used as an alternative method.
5. Sealing Seams: All edges and seams must be overlapped at least 2-1/2" (64 mm). Apply succeeding sheets with a minimum 2-1/2" (64 mm) overlap and stagger end laps. Roll or press the entire membrane firmly and completely as soon as possible. Patch misaligned or inadequately lapped seams with Bituthene Membrane. Slit any fish mouths, overlap the flaps, and repair with a patch of Bituthene and press or roll in place. The edges of the patch shall be sealed with a troweling of EM-3000. Laps within 12" (300 mm) of all corners shall be sealed with a troweling of EM-3000.
6. Corner Forming: Outside corners must be free of sharp edges. Inside corners should receive a fillet formed with Liquid Membrane LM-3000, latex modified cement mortar (such as Daraweld C mixed with cement mortar) or epoxy mortar. Do not use fiber or wood cants. One of two methods may be used for treating corners:
  - a. Apply Bituthene Liquid Membrane LM-3000 six inches (150 mm) in each direction from the corner and form a fillet with a minimum 3/4" (19 mm) face.
  - b. Install an 11" (280 mm) minimum strip of Bituthene membrane centered on the corner. Install Bituthene Membrane over the treated inside and outside corners.
7. Protection of Membrane: The Bituthene Protection System shall be used on foundation walls and vertical surfaces subject to damage from other trades.

#### B. Horizontal Surfaces

1. Priming: Application of primer shall be limited to what can be covered with Bituthene Waterproofing Membrane in a given workday. Primed areas not covered by membrane during the workday shall be re-primed. Apply by spray, roller or brush at a rate of 250 to 350 square feet per gallon. Roller should be a natural material such as lamb's wool, having a nap of approximately one inch (25 mm). Primer shall be applied to a clean, dry, frost-free and dust-free surface. Rollers should be dipped into pans to avoid pouring primer directly on the deck and creating puddles. Sufficient primer must be used to condition the surface to a dry, dust-free state suitable for the application of

Bituthene Waterproofing Membranes. Coverage of primer will vary due to the texture and porosity of the surface to receive the primer.

Bituthene P-3000 Primer should not be applied below 25°F (-4°C) on horizontal surfaces.

2. **Membrane Installation:** Bituthene Waterproofing Membrane shall be applied to the primed surface starting at the low point. Successive sheets should overlap preceding ones by 2-1/2" (64 mm). Two plies of Bituthene Membrane are recommended for below grade or earth shelter applications on any wood surfaces. All membrane shall be firmly rolled as soon as possible to minimize bubbles. Roller shall be a linoleum roller or standard water filled garden roller less than 30" (760 mm) wide, weighing approximately 75 pounds (34 kg) when filled. Cover the face of the roller with a resilient material such as 1/2" (13 mm) plastic foam or two wraps of indoor-outdoor carpet to allow the membrane to fully contact the primed substrate. Apply a double layer of Bituthene Membrane around posts or projections at least 6" (150 mm) in all directions and seal all terminations with Bituthene EM-3000. At drains, apply a bead of EM-3000 over a double layer of membrane under clamping rings. Apply EM-3000 at all terminations and at all "T" joints at the end of each workday.

An alternate method is to apply Bituthene Liquid Membrane LM-3000 around posts and protrusions, overlapping the sheet membrane a minimum of 2" (50 mm). At drains, apply LM-3000 from the center of the drain out to the sheet membrane overlapping it by a minimum of 2" (50 mm).

3. **Sealing Edges:** Bituthene Waterproofing Membrane shall be turned up on surrounding walls and terminated into a reglet or under counter flashing, or the membrane may be terminated directly on the vertical surface by pressing very firmly to the wall. Press edges with a metal or hardwood tool such as a hammer or knife handle. Apply a troweled bead of Bituthene Em-003000 to all vertical and horizontal terminations.
4. **Sealing Seams:** All edges and end seams must be overlapped at least 2-1/2" (64 mm). Apply succeeding sheets with a minimum 2-1/2" (64 mm) overlap and stagger end laps. Roll the entire membrane firmly and completely as soon as possible. Patch misaligned or inadequately lapped seams with Bituthene Waterproofing Membrane. Slit any fishmouths, overlap the flaps, and repair with a patch and press or roll in place. The edges of the patch shall be sealed with a troweling of EM-3000. Laps within 12" (300 mm) of all corners shall be sealed with a troweling of EM-3000.
5. **Corner Forming:** Outside corners must be free of sharp edges. Inside corners should receive a fillet formed with Liquid Membrane LM-3000, latex modified cement mortar (such as Daraweld C mixed with cement mortar) or epoxy mortar. Do not use fiber or wood cants. One of two methods may be used for treating corners:
  - a. Apply Bituthene Liquid Membrane LM-3000 6" (150 mm) in each direction from the corner and form a fillet with a minimum 3/4" (19 mm) face.
  - b. Install an 11" (280 mm) minimum strip of Bituthene Membrane centered on the corner. Install Bituthene waterproofing membrane over the treated inside and outside corners.
6. **Testing of horizontal waterproofing** shall be by flooding the entire waterproofed area with a minimum 2" (50 mm) head of water for 24 hours. Mark any leaks and repair when the membrane is dry. Before flood testing, ascertain from the structural engineer that the structure will withstand the dead load of the water.
7. **Protection of Membrane:** After testing the horizontal surfaces and allowing for the membrane to dry, apply the Bituthene Protection System to the entire horizontal surface.

#### **END OF SECTION**

## SECTION 07 21 00

### THERMAL INSULATION

#### **PART 1 – GENERAL**

##### 1.01 SUMMARY

Division 0, Contract requirements and Division 1, General Conditions apply to this section.

##### 1.02 SCOPE OF WORK SUMMARY

A. Furnish and install Thermal Insulation indicated on the Drawings and as specified herein.

B. The principal items of work include:

1. Thermal Insulation within roof.
2. Thermal Insulation within exterior walls.
3. Thermal Insulation within interior walls.
4. Thermal Insulation for below concrete slabs-on-grade.

##### 1.03 STANDARDS AND REFERENCES

A. American Society for Testing of Materials (ASTM):

1. ASTM C 518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
2. ASTM C 578: Standard Specification for Rigid Cellular Polystyrene Thermal Insulation.
3. ASTM C 612: Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
4. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
5. ASTM E 96: Standard Test Methods for Water Vapor Transmission of Materials.
6. ASTM E 119: Standard Test Methods for Fire Tests of Building Constructions and Materials.

B. NFPA 285: Standard Fire Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load Bearing Wall Assemblies Containing Combustible Components.

##### 1.04 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Upon completion of this portion of the Work, complete and post a certificate of insulation compliance in accordance with pertinent requirements of governmental agencies having jurisdiction.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00.

##### 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00.

B. Product data: Within 35 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:



1. Materials list of items to be provided under this Section.
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
3. Manufacturer's recommended installation procedures which, when accepted by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.

1.07 DELIVERY, STORAGE AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00 Temporary Facilities and Controls.
- B. Comply with Manufacturer's Standard Requirements

1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

1.10 WARRANTY

- A. Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.
- B. Contractor Guarantee: Contractor guarantees the work covered by this specification against all defects in material and workmanship for a period of not less than two (2) years from the date the Owner records Notice of Completion.

## **PART 2 – PRODUCTS**

2.01 MATERIALS

- A. Provide thermal insulation as indicated on Drawings. Insulation shall comply with ASTM Testing Standards and local Energy Codes. Fire Hazard Classification, Flame Spread Index, Smoke Developed Index, Combustibility, and Fire Endurance Ratings as required by Code.
- B. Insulation shall be as manufactured by Certain-Teed, Johns-Manville, Owens-Corning, or Architect approved equal.

2.02 BATT INSULATION MATERIALS

- A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used at Contractor's option.
- B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665, friction fit.
  1. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
  2. Flame Spread/Smoke Developed: 25/50 or less in accordance with ASTM E84.
  3. Basis-of-Design:
    - a. Owens Corning Corp: EcoTouch Pink Fiberglass Insulation
    - b. Recycled Content: minimum 55%
    - c. Certified Formaldehyde Free
    - d. Indoor Air Quality: Certified GreenGuard Gold

- C. Mineral Wool Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665, friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.

1. Combustibility: Non-combustible when tested in accordance with ASTM E136.
2. Basis-of-Design:
  - a. Owens Corning Corp: Thermafiber Insulation
  - b. Recycled Content: minimum 70%
  - c. Indoor Air Quality: Must meet or exceed standards established per California Department of Public Health Section 01350.

## 2.03 CONTINUOUS INSULATION MATERIALS

- A. Provide continuous insulation as indicated on Drawings.
- B. Rigid Polystyrene Board: ASTM C 578 Type IV Classification.
1. Basis-of-Design: Owens Corning Corp: Foamular 250 XPS Insulation
    - a. Thermal Resistance @ 75°F: R-5
    - b. Thermal Resistance @ 40°F: R-5.4
    - c. Water Absorption after 24 hrs submergence per ASTM C 272: 0.10%
    - d. Surface Burning Characteristics per ASTM E 84: Flame Spread >25; Smoke Developed >450
    - e. Compressive Strength: 25 psi minimum
    - f. Recycled Content: 20% minimum
- C. Mineral Wool Board: ASTM C 612 Types IA, IB, II, III, IVA.
1. Basis-of-Design: Owens Corning Corp: Thermafiber Continuous Insulation Rain Barrier
    - a. Thermal Resistance @ 75°F: R-4.2
    - b. Combustibility: Non-combustible when tested in accordance to ASTM E 136.
    - c. Surface Burning Characteristics per ASTM E 84: Flame Spread 0, Smoke Developed 0.
    - d. Compressive Strength: Type IA, IB, IVA @ 4.5 pcf; Type II, III @ 6 pcf
    - e. Recycled Content: 70% minimum
    - f. Insulation Retaining Clips: Thermafiber RainBarrier Clips

## 2.04 CURTAIN WALL INSULATION

- A. Where indicated, provide mineral wool insulation at the densities required. At gaps between perimeter edge of fire-resistant rated floor assemblies and non-fire-resistant exterior curtain walls, provide perimeter fire-containment system with the fire test response characteristics indicated as determined by testing per Underwriters Laboratories or Intertek (OPL) Laboratories.
1. Basis-of-Design: Owens Corning Corp: Thermafiber FireSpan 90 & Thermafiber FireSpan 40 Insulation.
    - a. Thermal Resistance @ 75°F: R-4.2
    - b. Facing: Unfaced/Foil Facing as per drawings.
    - c. Density: FireSpan 90 @ 8 pcf (nominal); FireSpan 40 @ 4 pcf (nominal)

- d. Surface Burning Characteristics per ASTM E 84: Flame Spread 0, Smoke Developed 0; Foil Faced material: Flame Spread 25, Smoke Developed 0.
- e. Recycled Content: minimum 70%

## 2. Safing Insulation

- a. Basis-of-Design: Owens Corning Corp: Thermafiber Safing Insulation
- b. Thermal Resistance @ 75°F: R-4.2
- c. Facing: Unfaced/Foil Facing as per drawings.
- d. Density: as per fire test
- e. Surface Burning Characteristics per ASTM E 84: Flame Spread 0, Smoke Developed 0; Foil Faced material - Flame Spread 25, Smoke Developed 0.
- f. Recycled Content: minimum 70%

## 3. Accessories

- a. Safing Clips: Z-shaped galvanized steel clips
- b. Hardware: Thermafiber Impasse hardware for attaching curtain insulation
  - 1. Mechanical fasteners as approved by Architect and Manufacturer
- c. Mullion covers
  - 1. 1-inch Thermafiber FireSpan 90 Insulation for protection of mullions.
  - 2. 2-inch Thermafiber FireSpan 90 Insulation for protection of mullions.
- d. Backer/Reinforcement Member: Thermafiber Impasse T-Bar or other light gauge steel channel or angle approved by manufacturer. Place horizontally at the safe-off line to support the curtain wall insulation to prevent bowing of curtain wall insulation caused by compression fitting of the safing insulation.
- e. Smoke Barrier: Smoke sealant as listed in the appropriate fire tested assembly and approved by the Architect and Manufacturer.
- f. Vapor Retarder Tape: Compatible with specified facer and comparable to perm rating. For taping insulation joints and repairing tears.

## 2.05 CONCRETE SLAB ON GRADE INSULATION

- A. Provide homogenous, hydrophobic extruded polystyrene rigid insulation board with compressive strength and thickness to meet foundation Ultimate Loads.

- 1. Basis-of-Design: Owens Corning Corp: Foamular XPS 250/400/600/1000
  - a. ASTM C578 Types and minimum Compressive Strengths:
    - Foamular 250: Type IV, 25 psi
    - Foamular 400: Type VI, 40 psi
    - Foamular 600: Type VII, 60 psi
    - Foamular 1000: Type V, 100 psi
  - b. Thermal Resistance @ 75°F: R-5 per inch
  - c. Thermal Resistance @ 40°F: R-5.4 per inch
  - d. Water absorption after 24 hrs submergence per ASTM C272: 0.05%
  - e. Water vapor permeance per ASTM E 96: 1.1 maximum perms
  - f. Indoor Air Quality: Meet GreenGuard Gold Certification

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Correct conditions detrimental to timely and proper completion of the Work.
- C. Do not proceed until unsatisfactory conditions are corrected.
- D. Beginning of installation means acceptance of conditions.

### **3.02 PREPARATION**

- A. Verify adjacent materials are dry and ready to receive installation.
- B. Verify mechanical and electrical services within walls have been installed and tested.

### **3.03 INSPECTION**

- A. Before any installation is started, determine that the other work is suitable to receive insulation.
- B. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.
- C. Remove or protect against projections in construction framing that may damage or prevent proper insulation.

### **3.04 INSTALLATION**

- A. All work shall be performed by licensed applicators, shall comply with the recommendations of the manufacturer and the National Association of Insulation Manufacturers.
- B. Install insulation with factory applied membrane facing warm side of building spaces. Lap ends and side flanges of membrane over and between framing members. Secure in place. Tape seal butt ends and lapped side flanges. Tape seal tears or cuts in membrane.
- C. Trim insulation neatly to fit spaces. Use batts free of damage. Install batt insulation, in wall spaces without gaps or voids.
- D. Install Insulation in all indicated walls from floor to underside of roof. Secure batt insulation with 19-gage wire or 1" wide, 20 gage steel strips. Architect shall approve all insulation details, including methods of fastening, before commencement of the work.

### **3.05 CLEAN UP AND DISPOSAL**

At frequent intervals during and again upon completion of work, remove from building and working premises tools and equipment, surplus materials, all rubbish and debris of whatever nature not caused by other trades, and leave the work in a clean, orderly and acceptable condition approved by the Architect.

**END OF SECTION**

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## SECTION 07 22 00

### ROOF AND DECK INSULATION

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract requirements and Division 1, General Conditions apply to this section.

##### 1.02 SCOPE OF WORK SUMMARY

A. Work included: Provide roof and deck insulation where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. Related Work:

1. Roofing.
2. Section 07 60 00: Flashing and Sheet Metal.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by the Manufacturer.

##### 1.04 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. In addition to complying with all pertinent codes and regulations of governmental agencies having jurisdiction, comply with the following:

1. Roof and deck insulation shall be FM approved and U. L. Classified.
2. Conform to Federal Specifications HH-1-1972/Gen, HH-1-1972/1, 2.
3. Meet California Quality Standards Registry Number CA-7006 (UT).

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

Provide in accordance with Section 01 33 00 Submittal Procedures.

##### 1.07 DELIVERY, STORAGE AND HANDLING

Comply with Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

A. Comply with the requirements of Section 01 50 00.

B. Comply with Manufacturer's Standard Requirements.

##### 1.09 OPERATIONS AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

##### 1.10 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

## PART 2 – PRODUCTS

### 2.01 MATERIALS

#### A. Insulation System:

1. Provide tapered and non-tapered expanded polystyrene thermal roof insulation in flutes of metal roof decks with the following physical properties:

Property:	ASTM Test Method:	Specification:
- Nom. Density LB/FT <sup>3</sup>		2.0
Thermal Resistance/R-Value (1 inch thickness)	C177/C518	4.76 at 40° F 4.35 at 75° F
Compressive resistance	D1621	25 (minimum psi)
Density	C303/D1622	1.80 (min. lb./ft. <sup>3</sup> )
Flexural strength - Transverse	C203	55-75 (minimum psi)
Water absorption by volume	C272	< 2%
Water vapor permeability	E96	0.60-2.0 Maximum (perm-inch)
Dimensional stability	D2126	< 2% (% Linear change, max.)
Flame spread	E84	< 25

2. Acceptable manufacturers - subject to compliance with requirements, provide products of one of the following:
  - a. Cellofoam, North America - Type IX, Tel: (800) 241-3634.
  - b. Atlas - ACFoam-II, Tel: (800) 477-1476.

#### B. Fastener System:

1. Provide a roof insulation fastener system for use in fastening insulation to steel decks. System shall be Factory Mutual approved for I-90 rating. Use manufacturer's recommendations as submitted and approved. Fastening shall be similar to:
2. Deck screws for metal deck applications shall be #12 gage and made of case-hardened carbon steel with gimlet point and Perma-Seal coated.
3. Stress plates shall be high-density polyethylene, 3-1/4" diameter, or G-90 galvanized steel, 3" square.
4. Acceptable Products: Rawl Deck Screw, and Rawl Stress Plates as manufactured by Rawlplug Company, Inc., New Rochelle, NY, or equal products of other manufacturers.

### 2.02 OTHER MATERIALS

Provide other materials not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the acceptance of the Architect.

## **PART 3 - EXECUTION**

### **3.01 SURFACE CONDITIONS**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Correct conditions detrimental to timely and proper completion of the Work.
- C. Remove or protect against projections in construction framing which may damage or prevent proper insulation.
- D. Before roof insulation application is started, remove trash, debris, oil, water, moisture and contaminants which may affect the attachment of the insulation to the surface. All depressions, holes, deformations, etc. shall be made smooth prior to the roof insulation application.
- E. The deck shall be sufficiently rigid to support the roofers and mechanical equipment without deflection that will strain or rupture any of the roofing components or deform the deck.
- F. Treated wood insulation stops, the same thickness as the insulation, shall be mechanically fastened at the edges of the deck and around all projection and openings through the deck.
- G. Do not proceed until unsatisfactory conditions are corrected.
- H. Beginning of installation means acceptance of conditions.

### **3.02 INSTALLATION**

Install the work of this Section in strict accordance with the original design, requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures as accepted by the Architect, anchoring all components firmly into position.

- 1. Deck screws shall penetrate metal deck a minimum of 1/2 inch.
- 2. Provide a minimum of one (1) fastener per 3 linear foot of surface area.
- 3. Cut insulation to fill flutes of metal deck prior to installation of roofing.

### **3.03 CLEANING**

Remove trash and debris from the roof insulation surface prior to the application of the roofing membrane.

### **3.04 PROTECTION**

- A. Installed insulation shall not be left exposed to the weather. It shall be covered and waterproofed at once.
- B. All exposed edges left at the end of a day's work shall be temporarily sealed by lapping roofing membrane over the exposed edge of the insulation and sealing it in place. Remove this membrane seal when work resumes. Installed insulation that becomes wet and/or damaged shall be removed and replaced with solid and dry materials.
- C. Protect installed insulation and membrane from roof traffic damage and/or abuse by using surface protection such as plywood in areas where heavy and/or repeated traffic is anticipated both during and after installation.

**END OF SECTION**



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## SECTION 07 25 00

### WEATHER BARRIER

#### PART 1 - GENERAL

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

A. Section includes products for weather barrier assemblies:

1. Commercial weather barrier assemblies.
2. Flexible flashing.
3. Weather barrier flashing.
4. Fluid-applied flashing.
5. Weather barrier accessories.
6. Drainage material.

B. Related Sections:

1. Section 07 42 46 "Cementitious Wall Panels" for installation of fiber-cement board siding.
2. Section 09 21 13 "Plaster Assemblies" for installation of stucco.

##### 1.03 STANDARDS AND REFERENCES

A. Comply with the Industry Standards and References as established by the Manufacturer.

B. Definitions

1. Weather Barrier: A combination of materials and accessories that attain the following:
  - a. Prevents the accumulation of water as a water-resistive barrier.
  - b. Minimizes the air leakage into or out of the building envelope as a continuous air barrier.
  - c. Provides sufficient water vapor transmission to enable drying as a vapor-permeable membrane.
2. Water-Resistive Barrier: Materials and accessories that prevent the accumulation of water within the wall assembly per California Building Code Section 1403.2.
3. Continuous Air Barrier: The combination of interconnected materials, assemblies, and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope per ASHRAE 90.1 section 5.4.3.1.
4. Vapor Diffusion: A slow movement of individual water vapor molecules from regions of higher to lower water vapor concentration (higher to lower vapor pressure).
5. Vapor Permeable Membrane: The property of having a water-vapor permeance rating of 10 perms (575 ng/Pa x s x sq. m) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E 96 per definition in International Building Code. Vapor permeable material permits the passage of moisture vapor through vapor diffusion.

##### 1.04 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is certified by weather barrier system manufacturer to install manufacturer's product.

- B. Mockups: Build mockups to set quality standards for materials and execution.
1. Build integrated mockups of exterior wall assembly, 10 feet by 10 feet, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of weather barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
    - a. Include junction with roofing membrane at parapet condition, and junction at foundation wall, fenestration and wall interface.
    - b. Provide mock-up in conjunction with fiber cement siding mock-up (refer to Section 07 46 46) to show incorporation/installation of fiber cement siding fasteners.
    - c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply weather barrier until mockups are approved.
  2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Manufacturer's Field Service: Register project with weather barrier manufacturer prior to installation of weather barrier and comply with weather barrier manufacturer's Project registration and observation process.
- D. Pre-installation Conference
1. Two weeks prior to start of weather barrier installation, conduct pre-installation conference. Include Owner, Architect, Manufacturer's Certified Installer, weather barrier manufacturer's designated field representative, and installers of work that interfaces with or affects weather barrier.
  2. Review methods and procedures related to weather barrier installation, including manufacturer's written instructions.
  3. Review and finalize construction, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  4. Examine substrate conditions and finishes for compliance with requirements.
  5. Review flashings, special weather barrier details, weather barrier penetrations, and condition of other construction that affects weather barrier.
  6. Review weather barrier manufacturer's Project Registration and Observation process.
  7. Review temporary protection requirements for weather barrier during and after installation.

#### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

#### 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00 Submittal Procedures.

B. Action Submittals

1. Product Data: For each type of product.
  - a. For weather barrier, include data on air and water-vapor permeance based

on testing in accordance with referenced standards.

2. Shop Drawings: Show details of weather barrier at terminations, openings, and penetrations. Show details of flexible flashing applications.

C. Informational Submittals

1. Evaluation Reports: For weather barrier and flexible flashing, from ICC-ES.
2. Manufacturer's Instructions: For installation of each product specified.
3. Qualification Data: For Installer
4. Sample Warranty: For manufacturer's warranty.
5. Reports: Field test and inspection reports.
6. Installer's weather barrier manufacturer-training certificate.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of Section 01 60 00 Materials and Equipment.
- B. Deliver weather barrier materials and components in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Do not store near heat source or open flame.

1.08 PROJECT CONDITIONS

Comply with the requirements of Section 01 50 00 Construction Facilities.

1.09 WARRANTY

- A. Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties and Bonds.
- B. Manufacturer's Product Warranty: To repair or replace weather barrier product that fails in materials within specified warranty period.
  1. Warranty Period: 10 years from date of purchase.
- C. Manufacturer's Product and Labor Warranty: Manufacturer agrees to repair or replace weather barrier that fails in materials within specified warranty period, including removal and replacement of affected construction up to manufacturer's limits.
  1. Warranty Period: 10 years from date of purchase.

**PART 2 - PRODUCTS**

2.01 MANUFACTURERS

- A. Basis of Design: Tyvek CommercialWrap D as manufactured by DuPont Safety & Construction: E. I. du Pont de Nemours and Company.
- B. Source Limitations: Obtain weather barrier assembly components from single manufacturer or from manufacturer approved by weather barrier manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed weather barrier and accessories shall withstand specified wind pressures, liquid water penetration, and water vapor pressures, without failure due to defective manufacture of products.
- B. High-Performance Installations:
  1. For installation with one of the following building envelope performance or structural

characteristics:

- a. Exceeding 65 mph (100 km/h) equivalent structural load.
- b. Exceeding 15 mph (24 km/h) equivalent wind-driven rainwater infiltration.

## 2.03 WEATHER BARRIER

- A. Basis of Design Product: Tyvek CommercialWrap and CommercialWrap D or Architect approved equal.
- B. System Description for use with wall panels and siding: Single-Layer Drainable Weather Barrier including flashing and sealing of penetrations and seams.
- C. System Description for use with plaster (stucco) assemblies and stone masonry wall finishes: Double-layer Drainable Weather Barrier including flashing and sealing of penetrations and seams, arranged as follows:
  - a. Primary Layer: Weather barrier with integral drainage installed closest to building interior.
  - b. Secondary Layer: 60 minute Grade D Building paper.
- D. Weather Barrier Characteristics
  1. Drainability: 98 percent or greater when tested in accordance with ASTM E 2273.
  2. Air Permeance, Product: Not more than 0.001 cfm/sq. ft. at 1.57 lbf/sq. ft. (0.005 L/s x sq. m at 75 Pa) when tested in accordance with ASTM E 2178.
  3. Air Permeance, Assembly: Not more than 0.04 cfm/sq. ft. at 1.57 lbf/sq. ft. (0.2 L/s x sq. m at 75 PA) when tested in accordance with ASTM E 2357 and evaluated by ABAA.
  4. Water Penetration Resistance, Product: Hydrostatic head resistance greater than 7.7 feet (2.35 m) in accordance with AATTC 127.
  5. Water Penetration Resistance, Assembly: Assembly wall specimen described in ASTM E 2357 to water resistance in accordance with ASTM E 331 to **2.86 lbf/sq. ft. (137 Pa)**
  6. Water-Vapor Permeance: Not less than 23 perms (1300 ng/Pa x s x sq. m) per ASTM E 96/E 96M, Desiccant Method (Procedure A) or not less than 28 perms (1600 ng/Pa x s x sq. m) per ASTM E 96/E 96M, Water Method (Procedure B).
  7. Water-Vapor Permeance: Not less than 30 perms (1700 ng/Pa x s x sq. m) per ASTM E 96/E 96M, Desiccant Method (Procedure A) or not less than 46 perms (2600 ng/Pa x s x sq. m) per ASTM E 96/E 96M, Water Method (Procedure B).
  8. Allowable UV Exposure Time: Not less than nine months when tested in accordance with ASTM G 155 (Accelerated Weathering).
  9. Flame Propagation Test: Materials and construction shall be as tested in accordance with NFPA 285.
  10. Heat and Visible Smoke Release Rates: Maximum rates in accordance with NFPA 285.
    - a. Peak Heat Release: 13,217 Btu/sq. ft. (150 kW/sq. m).
    - b. Total Heat Release: 1762 Btu/sq. ft. (20 MJ/sq. m)
    - c. Effective Heat of Combustion: 7744 Btu/lb (18 MJ/kg)
  11. Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E 84.

12. Weather barrier system to have a VOC content of 30 g/L or less.

#### 2.04 WEATHER BARRIER FLASHING

- A. Conformable Weather Barrier Flashing: Composite flashing material composed of micro-creped, polyethylene laminate with a 100 percent butyl-based adhesive layer able to create a seamless sill pan extending up the jambs without cuts, patches or fasteners; AAMA 711 Class A (no primer), Level 3 thermal exposure, 176 deg. F (80 deg. C) for 7 days.
1. Basis of Design Product: FlexWrap NF or Architect approved equal.
  2. Use 6" wide FlexWrap NF with 2 by 4 framing
  3. Use 9" wide FlexWrap NF with 2 by 6 framing
- B. Strip Flashing: Composite flashing material composed of spun-bonded polyethylene laminate with 100 percent butyl-based, dual-sided, adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure, 176 deg. F (80 deg. C) for 7 days.
1. Basis of Design Product: StraightFlash and StraightFlash VF or Architect approved equal.
- C. Flashing Characteristics:
1. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E 331.
  2. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg. F (minus 4 deg. C) as Class A without primer use.
  3. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.

#### 2.05 WEATHER BARRIER ACCESSORIES

- A. Seam Tape: Three-inch pressure-sensitive plastic tape recommended by weather barrier manufacturer for sealing joints and penetrations in weather barrier.
1. Basis-of-Design Product: DuPont Tyvek Tape or Architect approved equal.
- B. Sealant: Provide sealants that comply with ASTM C920, elastomeric polymer sealant to maintain watertight conditions.
1. OSI QuadMax
  2. Dow Corning 732, or 799
  3. Or Architect approved equal.
- C. Fasteners: Wood Frame Construction: Tyvek Wrap Caps as manufactured by DuPont; #4 nails with large 1-inch plastic cap fasteners or 1-inch plastic cap staples with leg length sufficient to achieve a minimum penetration of 5/8-inch into the wood stud.
- D. Primer for Flashings: Synthetic rubber-based product; spray applied. Strengthen adhesive bond at low temperature applications between weather products such as self-adhered flashing products, weather barriers, and common building sheathing materials.
1. Basis-of-Design Product: DuPont Adhesive Primer or Architect approved equal.
  2. Peel Adhesion Test: Passes in accordance with ASTM D 3330, Test Method F, for the following.
    - a. Peel Angles: 0, 25, 72, and 180 degrees.
    - b. Substrates: Concrete masonry units (CMU), exterior gypsum sheathing, oriented strand board (OSB), aluminum, and vinyl.
  3. Chemical Compatibility: Pass; AAMA 713.
  4. Flame Spread Index: 5; ASTM E 84.

5. Smoke Development Index: 0; ASTM E 84.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements.
- B. Verify that substrate and surface conditions are in accordance with commercial weather barrier manufacturer recommendations prior to installation.
  - 1. Verify that rough sill framing for doors and windows is sloped downwards towards the exterior and is level across width of the opening.
- C. Verify that surfaces to receive weather barrier flashing are clean, dry, and free of frost.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 PREPARATION**

- A. Direct water onto an acceptable weather barrier drainage plane with an unobstructed path to exterior of wall.
  - 1. Provide a drainage path for water intrusion through window and door attachment system that collects at window and door sills and directs water to the exterior or weather barrier

#### **3.03 WEATHER BARRIER INSTALLATION**

- A. General: Comply with weather barrier manufacturer's written instructions and warranty requirements.
- B. Cover exposed exterior surface of sheathing with weather barrier securely fastened to framing immediately after sheathing is installed.
  - 1. Maintain continuity of air and water barrier assemblies.
  - 2. Start weather barrier installation at a building corner, leaving 12 inches (300 mm) of weather barrier extended beyond corner to overlap.
  - 3. Install weather barrier horizontally starting at lower portion of wall surface.
  - 4. Provide minimum 6 inches (150 mm) overlap at horizontal- and vertical-wrap seams in a shingle manner to maintain continuous downward drainage plane and air and water barrier.
- C. Seams: Seal seams with weather barrier tape per manufacturer's recommended installation instructions.
  - 1. Shiplap horizontal seams in weather barrier to facilitate proper drainage.
- D. Fasteners: Use weather barrier manufacturer's recommended fasteners to secure weather barrier and install fasteners according weather barrier manufacturer's installation guidelines.
  - 1. Do not use temporary fasteners to permanently attach weather barrier.
  - 2. Do not place fasteners with gasketing washers where weather barrier flashing will be installed.
  - 3. Install fasteners with gasketing washers through flashing where recommended by manufacturer.
  - 4. Do not use fasteners into studs where installed behind fiber cement siding. Weather barrier shall be attached to continuous plywood substrate per manufacturer's

installation guidelines.

- E. Openings: Completely cover openings with weather barrier, then cut weather barrier membrane to openings according to weather barrier manufacturer's installation guidelines.
  - 1. Provide head and jamb flaps and seam overlaps to maintain continuous drainage.
  - 2. Repair damage to weather barrier using method recommended by weather barrier manufacturer.
  - 3. Install flashing according to weather barrier manufacturer's installation guidelines.

### 3.04 WEATHER BARRIER FLASHING INSTALLATION

- A. Installation: Remove wrinkles and bubbles, reposition weather barrier as necessary to produce a uniform, smooth surface.
  - 1. Ensure that ambient and substrate surface temperatures are acceptable in accordance with manufacturer instructions and recommendations.
  - 2. Wipe surfaces to remove moisture, dirt, grease and other debris that could interfere with adhesion.
  - 3. Apply weather barrier manufacturer's recommended primer over concrete, masonry, and glass-mat gypsum wall sheathing substrates to receive weather barrier flashing.
  - 4. Lap weather barrier flashing a minimum of 2 inches (50 mm) onto weather barrier.
  - 5. Apply pressure over entire surface using roller or firm hand pressure
- B. Rough Openings: Shiplap flashing with weather barrier in a shingle manner to maintain a continuous downward drainage plane and air and water barrier in accordance with manufacturer's written instructions.
  - 1. Apply conformable weather barrier flashing at door and window sills. Provide six inch wide flashing at 2 by 4 framing and nine inch wide flashing at 2 by 6 framing.
  - 2. Ensure that sill flashing does not slope to the interior.
  - 3. Install backer rod in joint between frame of opening product and flashed rough opening on the interior.
  - 4. Apply sealant or closed-cell polyurethane foam insulation around entire opening/fenestration product to create air seal around interior perimeter of window openings in accordance with weather barrier manufacturer's instructions.
  - 5. Around door and window openings, apply butyl-based flashing to flaps of weather barrier.
  - 6. Use strip flashing with wrap cap screws to secure head flap of the windows.
- C. Penetrations: Apply weather barrier manufacturer's recommended weather barrier flashing patches behind fastening plates, such as brick-tie base plates, metal-flashing clips, and metal channels.
  - 1. Seal weather barrier around each penetration with weather barrier manufacturer's recommended self-adhered flashing product or sealant. Integrate products with flanges into the weather barrier.
- D. Terminations: Provide minimum 2 inches (50 mm) overlap using strip flashing on adjoining roof and base of wall systems to maintain continuous downward drainage plane.
  - 1. Secure weather barrier with fasteners and weather-barrier flashing.

### 3.05 DRAINAGE MATERIAL INSTALLATION

Install drainage material with grooves or channels running vertically in compliance with



manufacturer's written instructions.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to train installers and observe subject test-wall areas and installations.

B. Field Quality Control Testing: Perform the following tests:

1. Air Infiltration Whole Building: ASTM E 779 at not more than 0.40 cfm/sf (2.00 L/s per sq. m-at 1.57 lb/sq. ft. (75 Pa).
2. Water Penetration: ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" article, but not less than 2.86 lbf/sq. ft. (137 Pa) No water penetration shall occur as defined in ASTM E 1105.
  - a. Perform a minimum of two tests in areas as directed by Architect.
  - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10 and 50 percent completion.

E. Prepare test and inspection reports.

3.07 CLEANING

Immediately remove release paper and scrap from work area and dispose of material in accordance with requirements of Section 01 74 00.

3.08 PROTECTION

A. Protect installed weather barrier from the following:

1. Damage from cladding, structure, or a component of the structure (e.g., window, door, or wall system).
2. Contamination from building site chemicals, premature deterioration of building materials, or nonstandard use or application of products.
3. Foreign objects or agents, including the use of materials incompatible with weather barrier products.
4. UV exposure in excess of products' stated limits.

**END OF SECTION**

## SECTION 07 26 13

### ABOVE-GRADE VAPOR RETARDER

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install above-grade vapor retarder, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00 Submittal Procedures.

B. Samples for Verification:

1. Vapor Retarder Facings: Nominal 6-inch (150-mm) square Samples.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

B. Deliver components so as not to be damaged or deformed.

##### 1.08 PROJECT CONDITIONS

Comply with the Manufacturer's Standard Requirements.

##### 1.9 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties and Bonds.

#### **PART 2 - PRODUCTS**

##### 2.01 MANUFACTURER

A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Lamtec Corporation. Address: 5010 River Road, Mt. Bethel, PA 18343-5610. Phone: 800-852-6832. Website: [www.lamtec.com](http://www.lamtec.com), Contact: [sales@lamtec.com](mailto:sales@lamtec.com)

B. Acceptable alternates

1. Raven Industries.
2. Reef Industries.

##### 2.02 PRODUCTS

A. Basis of Design Vapor-Retarder Facing: Lamtec WMP-10

1. Facing: Lamtec WMP-10.
  - a. Composition: 0.0015 inch (38.1 micron) white metallized polypropylene film, reinforcing layer, and 14 # (23 g/m<sup>2</sup>) white kraft paper.
    - i. Reinforcement: 5x5 tri-directional scrim which has a blend of fiberglass and polyester yarns.
    - ii. Color: Black
  - b. Performance:
    - i. Water Vapor Permeance: 0.02 perm (1.15 ng/N · s) per ASTM E 96, Procedure A.
    - ii. Mullen Burst: 65 psi (4.6 kg/cm<sup>2</sup>).
    - iii. Tensile Strength: 40 lbs/inch (7.0 kN/m) in the machine direction and 35 lbs/inch (6.1 kN/m) in the cross-machine direction.
  - c. Compliance: ASTM C 1136; ASTM C 991; ASTM E 84; ASTM E 96; ASTM C 1268; ASTM C 1338; Factory Mutual (FM) 4880; and UL 723.
- B. Vapor Retarder Tape: Pressure-sensitive tape of type recommended by the vapor retarder or tape manufacturer for small repairs and sealing around penetrations in vapor retarder. Should match the vapor retarder above.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Notify the Construction Manager and Architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

#### **3.02 PREPARATION**

- A. Clean and prepare surfaces to receive vapor retarder.

#### **3.03 INSTALLATION**

- A. Install concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.
- B. Refer for Section 07 21 00 and install concurrently with thermal insulation.
- C. Install in accordance with the industry guidelines found in North American Insulation Manufacturers Association (NAIMA) MB-316.

#### **3.04 CLEANING AND PROTECTION**

At frequent intervals during and again upon completion of work, remove from building and working premises tools and equipment, surplus materials, all rubbish and debris of whatever nature not caused by other trades, and leave the work in a clean, orderly and acceptable condition approved by the Architect.

**END OF SECTION**

## SECTION 07 26 16

### BELOW-GRADE VAPOR BARRIER

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract requirements and Division 1, General Conditions apply to this section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all below-grade vapor barriers, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete and proper installation.
- B. Section includes, but is not limited to:
  - 1. Section 02 06 14 and/or Soils Report for subgrade preparation.
  - 2. Section 03 30 00 Cast-in-Place Concrete.

##### 1.03 STANDARDS AND REFERENCES

- A. ASTM D1709 - 09 Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
- B. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
- C. ASTM E154 - Standard Test Methods for Water Vapor Barriers Used in Contact with Earth Under Concrete Slabs.
- D. ASTM E1643 - Standard Practice for Installation of Water Vapor Barriers Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- E. ASTM E1745 - Standard Specification for Plastic Water Vapor Barriers Used in Contact with Soil or Granular Fill Under Concrete Slabs.
- F. ASTM F1249-01 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

##### 1.04 QUALITY ASSURANCE

- A. Use an experienced installer and adequate number of skilled personnel who are thoroughly trained and experienced in the application of the vapor barrier.
- B. Obtain vapor barrier materials from a single manufacturer regularly engaged in manufacturing the product.
- C. Provide products which comply with all state and local regulations controlling use of volatile organic compounds (VOCs).
- D. Pre-Construction Meeting: Convene one week prior to installation of under slab vapor barrier. Attendees to be as follows: - Architect, Engineer, General Contractor, Vapor Barrier Installer, and Vapor Barrier Manufacturer to discuss the application in detail.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: Include independent laboratory test results showing compliance with ASTM and ACI Standards. Include manufacturer's installation instructions for placement, seaming, and pipe boot installation.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Store materials in a clean, dry area in accordance with manufacturer's instructions.
- C. Protect materials during handling and application to prevent damage or contamination
- D. Ensure membrane is stamped with manufacturer's name, product name, and membrane thickness at intervals of no more than 85" (220 cm).

1.08 PROJECT CONDITIONS

Comply with the requirements of Section 01 50 00.

1.09 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 – PRODUCTS**

2.01 MANUFACTURERS

- A. Perminator 15 Mil by W.R. Meadows
- B. Stego Wrap 15 Mil Vapor Barrier by Stego Industries
- C. Vapor-Block 15 Mil by Raven Industries
- D. Or Architect approved equal

2.02 MATERIALS

- A. Vapor Barrier must have the following qualities:
  - 1. 15 mil thickness minimum.
  - 2. Permeance of 0.01 UP perms as tested by ASTM E154.
  - 3. Puncture resistance of 2,200 grams per ASTM D1709, Method B.
  - 4. Tensile Strength of 45lbf/inch as per ASTM E1745-17
  - 5. ASTM E 1745 Class A (Plastics) after conditioning testing.
- B. Vapor Barrier Tape:
  - 1. As recommended by Vapor Barrier Manufacturer.
  - 2. Manufactured from High Density Polyethylene.
  - 3. Pressure Sensitive Adhesive.
- C. Pipe Boots: Construct from vapor barrier sheeting material and pressure sensitive tape in accordance with manufacturer's instructions.
- D. Sand: Clean yard sand, free from excessive dirt, debris, organic matter, and fines smaller than No. 200 sieve size.

**PART 3 – EXECUTION**

3.01 INSPECTION

- A. Below grade and grading work and items penetrating moisture barrier shall be completed prior to start of installation.

- B. Examine the areas and conditions under which work of this Section will be performed.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

3.02 INSTALLATION REQUIREMENTS

A. Vapor Barrier Sheeting:

1. Install in accordance with manufacturer's instructions and ASTM E1643.
2. Unroll with the longest dimension parallel with the direction of the pour.
3. Lap vapor barrier over footings and seal to foundation walls.
4. Overlap joints 6-inches and seal with manufacturer's pressure sensitive tape.
5. Seal penetrations, including pipes, with pipe boot.
6. Penetrations through vapor barrier sheeting except for reinforcing steel and permanent utilities are not permitted.
7. Repair damaged areas by cutting patches of vapor barrier sheeting, overlapping damaged area 6-inches and taping all four sides with pressure sensitive tape.

B. Sand Cushion:

1. Provide 2-inch layer over moisture barrier, unless otherwise indicated.
2. Spread over surfaces required and work to fill voids; leave in stable condition with finished surfaces reasonably uniform at established grade.

**END OF SECTION**

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## SECTION 07 54 00

### THERMOPLASTIC MEMBRANE ROOFING

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK

- A. To install an adhered Single Ply Thermoplastic (PVC) Roofing Membrane with flashings and other system components to comprise a roofing system for the County of San Bernardino, Training Facility, Colton, CA.
- B. System Description: PVC thermoplastic 72 Mil roofing membrane adhered over the existing BUR granular cap sheet using low-rise foam adhesive. Deck is metal with light weight concrete. Provide details as shown on the roof plan and detail sheet. Application includes wall flashing and coping metal.

##### 1.03 RELATED WORK

The work includes but is not necessarily limited to the installation of:

- 1. Adhesive for Flashings
- 2. Clad Edge Metal
- 3. Fasteners
- 4. Metal Flashings
- 5. Roof Membrane
- 6. Roof Membrane Flashings
- 7. Sealants
- 8. Separation Board
- 9. Substrate Preparation
- 10. Tapered Insulation
- 11. Walkways
- 12. Wood Blocking

##### 1.04 QUALITY ASSURANCE

- A. Membrane Manufacturer must certify that the proposed equal has a membrane thickness equal to the membrane thickness specified 72 mils thick, without ASTM (+/-) mil tolerance, as such tolerance is not acceptable. The felt backing shall not be included when measuring membrane thickness.
- B. Membrane must have at least thirty (30) mils of waterproofing polymers above the reinforcement as documented in the Typical Physical Properties section of the Manufacturer's published Product Data Sheet for 72 mil membranes.
- C. Roofing Membrane Manufacturer must have a demonstrated performance history of producing thermoplastic membranes no less, in duration of years, than the warranty duration specified.
- D. Membrane Manufacturer must provide a list of at least 10 (ten) projects in which the submitted roofing material has been performing for the specified warranty duration. Membranes with modified formulation changes and undocumented proven performance will not be accepted.
- E. Membrane Manufacturer must not require the use of membrane cut edge sealant at any location. This is a maintenance item that the Owner does not accept.
- F. Manufacturer's warranty must have "No Dollar Limit" for the replacement of defective materials and labor with no exclusions for ponding water.



- G. Membrane Manufacturer to confirm in writing that they directly manufacture the roofing membrane; private labeled membranes are not acceptable.
- H. Membrane Manufacturer must have an established program for recycling membrane at the end of its useful life. Must provide 3 (three) instances in which they have done so.
- I. Membrane Manufacturer must have recycled content certification from UL (Underwriters Laboratories) Environment.
- J. Membrane Manufacturer must have ISO 14001 Certification and a Responsible Care program in place.
- K. Upon completion of the installation and the delivery to the Manufacturer, by the Applicator of certification, that all work has been done in strict accordance with the contract specifications and Membrane Manufacturer's requirements, a Technical Service Representative will review the installed roof system.
- L. There is no deviation made from the project specification or the approved shop drawings without prior written approval by the Architect, the Owner's Representative and Roofing Manufacturer.
- M. The installer must have a minimum of 5 years' experience in installing roofing system of this type and nature. Contractor must be certified and approved by the roofing materials Manufacturer.
- N. All work pertaining to the installation of PVC membrane and flashings must only be completed by Applicator personnel trained and authorized by roofing Manufacturer in those procedures.
- O. Membrane to have no formulation changes in the last fifteen (15) years as certified by the manufacturer.

#### 1.05 SUBMITTALS

- A. All submittals which do not conform to the following requirements will be rejected. Submit proposed equals to be considered for use on this project no less than ten (10) days prior to bid date. Proposed roof systems which have been reviewed and accepted will be listed in an addendum prior to bid date; only then will roof systems be accepted at bidding. Submittals shall include the following:
  - 1. Copies of Specification including physical properties.
  - 2. Samples of each primary component to be used in the roof system and the manufacturer's current literature for each component.
  - 3. Written approval by the insulation manufacturer (as applicable) for use and performance of the product in the proposed system.
  - 4. Sample copy of Manufacturer's warranty including no exclusion for ponding water and no time limit shall be assigned to any such ponding water.
  - 5. Sample copy of Applicator's warranty.
  - 6. Dimensioned shop drawings which shall include:
    - a. Outline of roof with roof size and elevations shown.
    - b. Profile details of flashing methods for penetrations.
    - c. Technical acceptance from Manufacturer.
  - 7. Certifications by manufacturers of roofing and insulating materials that all materials supplied comply with all requirements of the identified ASTM and industry standards or practices and requirements of this specification as stated in Section 2.01, C & D and all requirements listed in Quality Assurance.

8. Certification from the Applicator that the system specified meets all identified code and insurance requirements as required by the Specification.
9. Letter from the proposed manufacturer confirming the number of years it has DIRECTLY manufactured the proposed roof system under the trade names and/or trademarks as proposed.
10. Material Safety Data Sheets (MSDS)

1.06 CODE REQUIREMENTS

The applicator shall submit evidence that the proposed roof system meets the requirements of the local building code and has been tested and approved or listed by the following test organizations. These requirements are minimum standards and no roofing work shall commence without written documentation of the system's compliance, as required in the "Submittals" section of this specification.

- A. Factory Mutual Research Corporation (FM) - Norwood, MA
  1. Class 1-90 (Attachment Criteria)
- B. Underwriters Laboratories, Inc. - Northbrook, IL
  1. Class A assembly

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All products delivered to the job site shall be in the original unopened containers or wrappings bearing all seals and approvals.
- B. Handle all materials to prevent damage. Place all materials on pallets and fully protect from moisture.
- C. Membrane rolls shall be stored lying down on pallets and fully protected from the weather with clean canvas tarpaulins. Unvented polyethylene tarpaulins are not accepted due to the accumulation of moisture beneath the tarpaulin in certain weather conditions that may affect the ease of membrane weldability.
- D. All adhesives shall be stored at temperatures between 40° F (5° C) and 80° F (27° C).
- E. All flammable materials shall be stored in a cool, dry area away from sparks and open flames. Follow precautions outlined on containers or supplied by material manufacturer/supplier.
- F. All materials which are determined to be damaged by the Owner's Representative or the manufacturer are to be removed from the job site and replaced at no cost to the Owner.

1.08 JOB CONDITIONS

- A. Membrane materials may be installed under certain adverse weather conditions but only after consultation with the Manufacturer, as installation time and system integrity may be affected.
- B. Only as much of the new roofing as can be made weathertight each day, including all flashing and detail work, shall be installed. All seams shall be cleaned, and heat welded before leaving the job site that day.
- C. All work shall be scheduled and executed without exposing the interior building areas to the effects of inclement weather. The existing building and its contents shall be protected against all risks.
- D. All surfaces to receive new insulation, membrane or flashings shall be dry. Should surface moisture occur, the Applicator shall provide the necessary equipment to dry the surface prior to the application.
- E. All new and temporary construction, including equipment and accessories, shall be secured in such a manner as to preclude wind blow-off and subsequent roof or equipment damage.

- F. Uninterrupted waterstops shall be installed at the end of each day's work and shall be completely removed before proceeding with the next day's work. Waterstops shall not emit dangerous or unsafe fumes and shall not remain in contact with the finished roof as the installation progresses. Contaminated membrane shall be replaced at no cost to the Owner.
- G. The Applicator is cautioned that certain membranes are incompatible with asphalt, coal tar, heavy oils, roofing cements, creosote, and some preservative materials. Such materials shall not remain in contact with the membranes. The Applicator shall consult the manufacturer regarding compatibility, precautions, and recommendations.
- H. Arrange work sequence to avoid use of newly constructed roofing as a walking surface or for equipment movement and storage. Where such access is absolutely required, the general contractor or construction manager shall provide for all necessary protection and barriers as required to segregate the work area and to prevent damage to adjacent areas. A substantial protection layer consisting of plywood over Felt or plywood over insulation board shall be provided for all new and existing roof areas that receive rooftop traffic during construction.
- I. Prior to and during application, all dirt, debris and dust shall be removed from surfaces by vacuuming, sweeping, blowing with compressed air and/or similar methods.
- J. The Applicator shall follow all safety regulations as required by OSHA and any other applicable authority having jurisdiction.
- K. All roofing, insulation, flashings, and metal work removed during construction shall be immediately taken off site to a legal dumping area authorized to receive such materials. Hazardous materials, such as materials containing asbestos, are to be removed and disposed of in strict accordance with applicable City, State and Federal requirements.
- L. All new roofing waste material (i.e., scrap roof membrane, empty cans of adhesive) shall be immediately removed from the site by the Applicator and properly transported to a legal dumping area authorized to receive such material.
- M. The Applicator shall take precautions that storage and/or application of materials and/or equipment does not overload the roof deck or building structure.
- N. Flammable adhesives and deck primers shall not be stored and not be used in the vicinity of open flames, sparks and excessive heat.
- O. All rooftop contamination that is anticipated or that is occurring shall be reported to the manufacturer to determine the corrective steps to be taken.
- P. The Applicator shall verify that all roof drain lines are functioning correctly (not clogged or blocked) before starting work. Applicator shall report any such blockages in writing (letter copy to the manufacturer) to the Owner's Representative for corrective action prior to installation of the roof system.
- Q. Applicator shall immediately stop work if any unusual or concealed condition is discovered and shall immediately notify Owner of such condition in writing for correction at the Owner's expense (letter copy to the manufacturer).
- R. Site cleanup, including both interior and exterior building areas that have been affected by construction, shall be completed to the Owner's satisfaction.
- S. All landscaped areas damaged by construction activities shall be repaired at no cost to the Owner.
- T. The Applicator shall conduct fastener pullout tests in accordance with the latest revision of the SPRI/ANSI Fastener Pullout Standard to help verify condition of deck/substrate and to confirm expected pullout values.
- U. The adhered membrane shall not be installed under the following conditions without consulting the manufacturer's technical department for precautionary steps:
  - 1. The roof assembly permits interior air to pressurize the membrane underside.

2. Any exterior wall has 10% or more of the surface area comprised of opening doors or windows.
  3. The wall/deck intersection permits air entry into the wall flashing area.
- V. Precautions shall be taken when using adhesives at or near rooftop vents or air intakes. Adhesive odors could enter the building. Coordinate the operation of vents and air intakes in such a manner as to avoid the intake of adhesive odor while ventilating the building. Always keep lids on unused cans.
- W. Protective wear shall be worn when using solvents or adhesives or as required by job conditions.

#### 1.09 BIDDING REQUIREMENTS

- A. Site Visit: Bidders shall visit the site and carefully examine the areas in question as to conditions that may affect proper execution of the work. All dimensions and quantities shall be determined or verified by the contractor. No claims for extra costs will be allowed because of lack of full knowledge of the existing conditions unless agreed to in advance with the Owner or Owner's Representative.

#### 1.10 WARRANTIES

- A. Manufacturer's System Warranty (only products purchased from the membrane manufacturer are covered under System Warranty): Upon successful completion of the work to the Roofing Manufacturer's and Owner's satisfaction, and receipt of final payment, the twenty-five (25) Year System Warranty shall be issued. The System Warranty shall provide for the roof membrane, all accessories that comprise a roof system, and contractor labor. The Warranty shall be **Non-Prorated** provide for No Dollar Limit (NDL) and **shall not exclude ponding water and no time limited shall be assigned for any such ponding water during the warranty period**. Warranty shall not exclude regular foot traffic or storage on the roof surface, and it shall not obligate the owner to a maintenance schedule of any type as a condition of the warranty.
- B. Applicator/Roofing Contractor Warranty: The Applicator shall supply the Owner with a separate five-year workmanship warranty. In the event any work related to roofing, flashing, or metal is found to be within the Applicator warranty term, defective or otherwise not in accordance with the Contract Documents, the Applicator shall repair that defect at no cost to the Owner. The Applicator's warranty obligation shall run directly to the Owner, and a copy shall be sent to the manufacturer.
- C. Owner Responsibility: Owner shall notify both the manufacturer and the Applicator of any leaks as they occur during the time when both warranties are in effect.

### **PART 2 – PRODUCTS**

#### 2.01 GENERAL

- A. The components of the Adhered roof system are to be products of the membrane manufacturer as indicated on the Detail Drawings and specified in the Contract Documents.
- B. Components to be used that are other than those supplied or manufactured by the membrane manufacturer may be submitted for review and acceptance by the manufacturer. The manufacturer's acceptance of any other product is only for a determination of compatibility with membrane products and not for inclusion in the manufacturer's warranty. The specifications, installation instructions, limitations, and/or restrictions of the respective manufacturers must be reviewed by the Owner's Representative for acceptability for the intended use with the manufacturer's products.

- C. Membrane shall be certified by the manufacturer to be the exact thickness, as specified, ASTM tolerance does not apply.
- D. Membrane shall have a minimum of thirty (30) mils of waterproofing polymers above the reinforcements as documented by a third-party source.

## 2.02 MEMBRANE

- A. Basis of Design: Sarnafil® G410 Feltback fiberglass reinforced membrane with a factory-applied integral lacquer coating to repel dirt and sustain reflectivity.
- B. Membrane shall conform to ASTM D4434-15 (or latest revision), "Standard for Polyvinyl Chloride Sheet Roofing". Classification: Type II, Grade I.
  - 1. Sarnafil G410-18 feltback, 72 mil (1.8 mm), thermoplastic membrane with fiberglass reinforcement and a factory applied 9 oz. geotextile felt backing.
  - 2. Or Pre-Approved Equal, subject to compliance with all specification requirements herein so stated. KEE and other like-type, non-conforming membrane products will not be approved as equal. Type III scrim reinforced membranes will not be considered for adhered applications.
- C. Color of Membrane
  - 1. EnergySmart feltback (White), initial reflectivity of 0.83, initial emissivity 0.92, solar reflective index (SRI) of >104.
- D. Typical Physical Properties

<u>Parameters</u>	<u>ASTM Test Method</u>	<u>Minimum ASTM Requirement</u>
Reinforcing Material	-	Fiberglass
Overall Thickness, min., inches (mm)	D638	[0.072inches]]
Tensile Strength, min., psi (MPa)	D638	1600 (11.1)
Elongation at Break, min. (machine x tranverse)	D638	270% / 250%
Seam strength*, min. (% of tensile strength)	D638	80
Retention of Properties After Heat Aging	D3045	-
Tensile Strength, min., (% of original)	D638	95
Elongation, min., (% of original)	D638	90
Tearing Resistance, min., lbf (N)	D1004	14 (63.0)
Low Temperature Bend, -40° F (-40° C)	D2136	Pass
Accelerated Weathering Test (Xenon Arc)	D2565	10,000 Hours
Cracking (7x magnification)	-	None
Discoloration (by observation)	-	Negligible
Crazing (7 x magnification)	-	None
Linear Dimensional Change	D1204	0.02%
Weight Change After Immersion in Water	D570	2.5%
Static Puncture Resistance, 33 lbf (15 kg)	D5602	Pass
Dynamic Puncture Resistance, 7.3 ft-lbf (10 J)	D5635	Pass

\*Failure occurs through membrane rupture, not seam failure.

## 2.03 FLASHING MATERIALS

### A. Wall/Curb/Perimeter Flashing

1. Flashing Membrane: A fiberglass reinforced membrane adhered to approved substrate using adhesive.
2. Clad: A PVC-coated, heat-weldable sheet metal capable of being formed into a variety of shapes and profiles. Clad is a 25 gauge, G90 galvanized metal sheet with a 20 mil (1 mm) unsupported membrane laminated on one side.
3. Coping Metal: Wall Grip Coping is formed from .063 in (1.60 mm) or .050 in (1.25 mm) aluminum; 24ga. galv. steel with Kynar 500® coating. Cleats are 20ga. galvanized steel. Chairs are metal in the same color and finish as the coping cap. Fabricated to the wall width required between 6 in and 32 in. Face and back leg are 4 in (102mm) nominal length with tested approvals up to 6" (152mm).

### B. Miscellaneous Flashing

1. Flash: A prefabricated expansion joint cover made from membrane. Flash is designed for securement to wall or horizontal surfaces to span and accommodate the movement of new and existing expansion gaps from 1 inch to 4½ inches (25 mm to 114 mm) across.
2. Reglet: A heavy-duty, extruded aluminum flashing termination reglet used at walls and large curbs. Reglet is produced from 6063-T5, 0.10 inch - 0.12 inch (2.5 mm - 3.0 mm) thick extruded aluminum. Reglet has a 2¼ inch (57 mm) deep profile and is provided in 10-foot (3 m) lengths. Use prefabricated Reglet mitered inside and outside corners where walls intersect.
3. Stack: A prefabricated vent pipe flashing made from 0.048 inch (48 mil/1.2 mm) thick G410 membrane.
4. Circle-"G": Circular 0.048 inch (48 mil/1.2 mm) thick G410 membrane patch welded over T-joints formed by overlapping thick membranes.
5. Corner: Prefabricated outside and inside flashing corners made of 0.060 inch (60 mil/1.5 mm) thick membrane that are heat-welded to membrane or Clad base flashings. Corner is available in 2 outside sizes (5 inch and 8½ inch diameter/127 mm and 215 mm) and 1 inside size.
6. Multi-Purpose Sealant: A sealant used at flashing terminations.
7. StaBond Adhesive: A solvent-based reactivating-type adhesive used to attach membrane to flashing substrate.
8. Felt: A non-woven polyester or polypropylene mat cushion layer that is necessary behind G410 or G459 Flashing Membrane when the flashing substrates are rough-surfaced or incompatible with the flashing membrane.
9. Flashing G459 Membrane: An asphalt-resistant, fiberglass reinforced membrane adhered to approved substrate using adhesive.
10. Flashing, G410, 60 Mil SA Membrane: Self-adhered, fiberglass reinforced membrane with adhesive backing and a plastic release liner to the sheet underside for adhesion to approved substrates.

## 2.04 ATTACHMENT COMPONENTS

- A. Plate: Used with various Fasteners to attach insulation boards to roof deck. Plate is a 3-inch (75 mm) square or round, 26-gauge stamping of SAE 1010 steel with an AZ 55 Galvalume coating.

- B. Fastener No. 12: Number 12 corrosion-resistant fastener used with Plates to attach insulation boards to steel or wood roof decks. Fastener No. 12 has a modified buttress thread, a shank diameter of approximately 0.168 inch (4 mm) and a thread diameter of approximately 0.214 inch (5 mm). The driving head has a diameter of approximately 0.435 inch (11 mm) with a #3 Phillips recess for positive engagement.
- C. Fastener-XP: A #15, heavy-duty, corrosion-resistant fastener used with Plate to attach insulation or Stop and Bar to attach G410 roof membrane to steel or wood roof decks. Fastener-XP has a shank diameter of approximately 0.21 inch (5.3 mm) and the thread diameter is approximately 0.26 inch (6.6 mm). The driving head has a diameter of approximately 0.435 inch (11 mm) with a #3 Phillips recess for positive engagement.
- D. Fastener-XPS: A specially designed, heavy-duty, corrosion-resistant fastener used with Stop or Bar to attach G410 roof membrane to steel roof decks. Fastener-XPS has a shank diameter of approximately 0.21 inch (5.3mm) and a thread diameter of approximately 0.26 inch (6.6). The driving head has a diameter of approximately 0.435 inch (11 mm) with a #3 Phillips recess for positive engagement and simplicity of application.
- E. Fastener-King Con: A nail-in, corrosion-resistant fastener used with Plate to attach insulation or with Bar to attach membrane to poured structural concrete roof decks.
- F. Stop: An extruded aluminum, low profile bar used with certain Fasteners to attach to the roof deck or to walls/curbs at terminations, penetrations and at incline changes of the substrate. Stop is a 1 inch (25 mm) wide, flat aluminum bar 1/8 inch (3 mm) thick that has predrilled holes every 6 inches (152 mm) on center.
- G. Bar: An FM-approved, heavy-duty, 14 gauge, galvanized or stainless, roll-formed steel bar used to attach membrane to roof decks. The formed steel is pre-punched with holes every 1 inch (25 mm) on center to allow various Fastener spacing options.
- H. Cord: A 5/32-inch (4 mm) diameter, red-colored, flexible thermoplastic extrusion that is welded to the top surface of the membrane and against the side of the Bar, used to hold the membrane in position.

## 2.05 WALKWAY PROTECTION

- A. Tread: A polyester reinforced, 0.096 inch (96 mil/2.4 mm), weldable membrane with surface embossment. Used as a protection layer from rooftop traffic. Tread is supplied in rolls of 39.3 inches (1.0 m) wide and 32.8 feet (10 m) long.

## 2.06 MISCELLANEOUS ACCESSORIES

- A. Aluminum Tape: a 2-inch (50 mm) wide pressure-sensitive aluminum tape used as a separation layer between small areas of asphalt contamination and the membrane and as a bond-breaker under the cover strip at Clad joints.
- B. Sealing Tape Strip: Compressible foam with pressure-sensitive adhesive on one side. Used with metal flashings as a preventive measure against air and wind-blown moisture entry.
- C. Multi-Purpose Tape: A high performance sealant tape with used with metal flashings as a preventive measure against air and wind-blown moisture entry.
- D. Seam Welder 641mc: 220 volt, self-propelled, hot-air welding machine used to seal long lengths of membrane seams.
- E. Perimat Welder: 120 volt, self-propelled, hot-air welding machine used to seal long-lengths of membrane seams along perimeter details.
- F. Solvent: A high quality solvent cleaner used for the general cleaning of residual asphalt, scuff marks, etc., from the membrane surface. Solvent is also used daily to clean seam areas prior to hot-air welding in tear off or dirty conditions or if the membrane is not welded the same day it is unrolled. Consult Product Data Sheet for additional information.

## 2.07 MISCELLANEOUS FASTENERS AND ANCHORS

- A. All fasteners, anchors, nails, straps, bars, etc. shall be post-galvanized steel, aluminum or stainless steel. Mixing metal types and methods of contact shall be assembled in such a manner as to avoid galvanic corrosion. Fasteners for attachment of metal to masonry shall be expansion type fasteners with stainless steel pins. All concrete fasteners and anchors shall have a minimum embedment of 1¼ inch (32 mm) and shall be approved for such use by the fastener manufacturer. All miscellaneous wood fasteners and anchors used for flashings shall have a minimum embedment of 1 inch (25 mm) and shall be approved for such use by the fastener manufacturer.

## 2.08 RELATED MATERIALS

- A. Wood Nailer: Treated wood nailers shall be installed at the perimeter of the entire roof and around such other roof projections and penetrations as specified on Project Drawings. Thickness of nailers must match the insulation thickness to achieve a smooth transition. Wood nailers shall be treated for fire and rot resistance (wolmanized or osmose treated) and be #2 quality or better lumber. Creosote or asphalt-treated wood is not acceptable. Wood nailers shall conform to Factory Mutual Loss Prevention Data Sheet 1-49. All wood shall have a maximum moisture content of 19% by weight on a dry-weight basis.
- B. Plywood: When bonding directly to plywood, a minimum ½ inch (12 mm) CDX (C side out), smooth-surfaced exterior grade plywood with exterior grade glue shall be used. Rough-surfaced plywood or high fastener heads will require the use of Felt behind the flashing membrane. Plywood shall have a maximum moisture content of 19% by weight on a dry weight basis.

## **PART 3 – EXECUTION**

### 3.01 PRE-CONSTRUCTION CONFERENCE

- A. The Applicator, Owner's Representative/Designer and Manufacturer(s) shall attend a pre-construction conference.
- B. The meeting shall discuss all aspects of the project including but not limited to:
1. Safety
  2. Set up
  3. Construction schedule
  4. Contract conditions
  5. Coordination of the work

### 3.02 SUBSTRATE CONDITION

- A. Applicator shall be responsible for acceptance or provision of proper substrate to receive new roofing materials.
- B. Applicator shall verify that the work done under related sections meets the following conditions:
1. Roof drains and/or scuppers have been reconditioned and/or replaced and installed properly.
  2. Roof curbs, nailers, equipment supports, vents and other roof penetrations are properly secured and prepared to receive new roofing materials.
  3. All surfaces are smooth and free of dirt, debris, and incompatible materials.
  4. All roof surfaces shall be free of water, ice, and snow.

### 3.03 SUBSTRATE PREPARATION

The roof deck and existing roof construction must be structurally sound to provide support for the new roof system. The Applicator shall load materials on the rooftop in such a manner to eliminate



risk of deck overload due to concentrated weight. The Owner's Representative shall ensure that the roof deck is secured to the structural framing according to local building code and in such a manner as to resist all anticipated wind loads in that location.

A. Re-roofing Over Existing Bitumen Roofing

1. On smooth surfaced roofs, the surface must be clean and dry. All blisters shall be removed and sealed or cut, fastened down and sealed. For Type III hot asphalt attachment of new insulation board, priming of the old roof surface after preparation is necessary.

3.04 SUBSTRATE INSPECTION

- A. A dry, clean, and smooth substrate shall be prepared to receive the Adhered roof system.
- B. The Applicator shall inspect the substrate for defects such as excessive surface roughness, contamination, structural inadequacy, or any other condition that will adversely affect the quality of work.
- C. The substrate shall be clean, smooth, dry, free of flaws, sharp edges, loose and foreign material, oil, and grease. Roofing shall not start until all defects have been corrected.
- D. All roof surfaces shall be free of water, ice and snow.
- E. The membrane shall be applied over compatible and accepted substrates only.

3.05 WOOD NAILER INSTALLATION

- A. Install continuous wood nailers at the perimeter of the entire roof and around roof projections and penetrations as shown on the Detail Drawings.
- B. Nailers shall be anchored to resist a minimum force of 300 pounds per lineal foot (4,500 Newtons/lineal meter) in any direction. Individual nailer lengths shall not be less than 3 feet (0.9 meter) long. Nailer fastener spacing shall be at 12 inches (0.3 m) on center or 16 inches (0.4 m) on center, if necessary, to match the structural framing. Fasteners shall be staggered 1/3 the nailer width and installed within 6 inches (0.15 m) of each end. Two fasteners shall be installed at ends of nailer lengths. Nailer attachment shall meet this requirement and that of the current Factory Mutual Loss Prevention Data Sheet 1-49.
- C. Thickness shall be as required to match substrate or insulation height to allow a smooth transition.
- D. Any existing nailer woodwork which is to remain shall be firmly anchored in place to resist a minimum force of 300 pounds per lineal foot (4,500 Newtons/lineal meter) in any direction and shall be free of rot, excess moisture, or deterioration. Only woodwork shown to be reused in Detail Drawings shall be left in place. All other nailer woodwork shall be removed.

3.06 INSTALLATION OF ROOF MEMBRANE

The surface of the insulation or substrate shall be inspected prior to installation of the roof membrane. The substrate shall be clean, dry, free from debris and smooth with no surface roughness or contamination. Broken, delaminated, wet or damaged insulation boards shall be removed and replaced.

A. Membrane Installation, Low-Rise Foam:

1. Position and unroll successive sheets of feltback membrane and align to provide a minimum 3 inch (76 mm) wide overlap.
2. Fold adjacent sheet in half lengthwise to expose substrate area. Fold selvage Sheet edges (along the length of the sheets) under the membrane to prevent overspray onto weld area. Adhere membrane that will be bottom side of the weld first. This will protect the selvage edge from being contaminated by setting into Low Rise Foam adhesive.
3. Spray Low Rise Foam adhesive onto the substrate and allow to rise approximately 1/8 inch (45.7 cm).

4. Place membrane into Low Rise Foam adhesive and roll with water filled, foam covered lawn roller to set into adhesive.
5. Fold remaining sheets lengthwise to expose additional substrate area adjacent to area previously adhered.
6. Apply Low Rise Foam adhesive to substrate and continue process described above until all sheets are adhered.
7. Hot-air weld all seams.

### 3.07 HOT-AIR WELDING OF SEAM OVERLAPS

#### A. General

1. All seams shall be hot-air welded. Seam overlaps should be 3 inches (75 mm) wide when automatic machine-welding and 4 inches (100 mm) wide when hand-welding, except for certain details.
2. Welding equipment shall be provided by or approved by the manufacturer. All mechanics intending to use the equipment shall have successfully completed a training course provided by a Technical Representative prior to welding.
3. All membrane to be welded shall be clean and dry.

#### B. Hand-Welding

1. Hand-welded seams shall be completed in two stages. Hot-air welding equipment shall be allowed to warm up for at least one minute prior to welding.
2. The back edge of the seam shall be welded with a narrow but continuous weld to prevent loss of hot air during the final welding.
3. The nozzle shall be inserted into the seam at a 45-degree angle to the edge of the membrane. Once the proper welding temperature has been reached and the membrane begins to "flow," the hand roller is positioned perpendicular to the nozzle and pressed lightly. For straight seams, the 1½ inch (40 mm) wide nozzle is recommended for use. For corners and compound connections, the ¾ inch (20 mm) wide nozzle shall be used.

#### C. Machine Welding

1. Machine welded seams are achieved using automatic welding equipment. When using this equipment, the manufacturer's instructions shall be followed and local codes for electric supply, grounding and over current protection observed. Dedicated circuit house power or a dedicated portable generator is recommended. No other equipment shall be operated off the generator.
2. Metal tracks may be used over the deck membrane and under the machine welder to minimize or eliminate wrinkles.

#### D. Quality Control of Welded Seams

1. The Applicator shall check all welded seams for continuity using a rounded screwdriver. Visible evidence that welding is proceeding correctly is smoke during the welding operation, shiny membrane surfaces, and an uninterrupted flow of dark grey material from the underside of the top membrane. On-site evaluation of welded seams shall be made daily by the Applicator to locations as directed by the Owner's Representative or a manufacturer's representative. One inch (25 mm) wide cross-section samples of welded seams shall be taken at least three times a day. Correct welds display failure from shearing of the membrane prior to separation of the weld. Each test cut shall be patched by the Applicator at no extra cost to the Owner.

### 3.08 MEMBRANE FLASHINGS

All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and the manufacturer. Approval shall only be for specific locations on specific

dates. If any water enters under the newly completed roofing, the affected area shall be removed and replaced at the Applicator's expense. Flashing shall be adhered to compatible, dry, smooth, and solvent-resistant surfaces. Use caution to ensure adhesive fumes are not drawn into the building.

A. Adhesive for Membrane Flashings

1. Over the properly installed and prepared flashing substrate, adhesive shall be applied according to instructions found on the Product Data Sheet. The adhesive shall be applied in smooth, even coats with no gaps, globs, or similar inconsistencies. Only an area which can be completely covered in the same day's operations shall be flashed. The bonded sheet shall be pressed firmly in place with a hand roller.
  2. No adhesive shall be applied in seam areas that are to be welded. All panels of membrane shall be applied in the same manner, overlapping the edges of the panels as required by welding techniques.
- B. Install Stop/Bar/Cord according to the Detail Drawings with approved fasteners into the structural deck at the base of parapets, walls, and curbs. Stop is required by the manufacturer at the base of all tapered edge strips and at transitions, peaks, and valleys according to the manufacturer's details.
- C. The manufacturer's requirements and recommendations and the specifications shall be followed. All material submittals shall have been accepted by the manufacturer prior to installation.
- D. All flashings shall extend a minimum of 8 inches (0.2 m) above roofing level unless otherwise accepted in writing by the Owner's Representative and the Technical Department.
- E. All flashing membranes shall be consistently adhered to substrates. All interior and exterior corners and miters shall be cut and hot-air welded into place. No bitumen shall be in contact with the membrane.
- F. All flashing membranes shall be mechanically fastened along the counter-flashed top edge with Stop at 6-8 inches (0.15-0.20 m) on center.
- G. Flashings shall be terminated according to the manufacturer's recommended details.
- H. All flashings that exceed 30 inches (0.75 m) in height shall receive additional securement. Consult Technical Department for securement methods.

3.09 METAL FLASHINGS

- A. Metal details, fabrication practices and installation methods shall conform to the applicable requirements of the following:
1. Factory Mutual Loss Prevention Data Sheet 1-49 (latest issue).
  2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - latest issue.
- B. Metal, other than that provided by the manufacturer, is not covered under the warranty.
- C. Complete all metal work in conjunction with roofing and flashings so that a watertight condition exists daily.
- D. Metal shall be installed to provide adequate resistance to bending to allow for normal thermal expansion and contraction.
- E. Metal joints shall be watertight.
- F. Metal flashings shall be securely fastened into solid wood blocking. Fasteners shall penetrate the wood nailer a minimum of 1 inch (25 mm).

- G. Airtight and continuous metal hook strips are required behind metal fascias. Hook strips are to be fastened 12 inches (0.3 m) on center into the wood nailer or masonry wall.
- H. Counter flashings shall overlap base flashings at least 4 inches (100 mm).
- I. Hook strips shall extend past wood nailers over wall surfaces by 1½ inch (38 mm) minimum and shall be securely sealed from air entry.

### 3.10 CLAD METAL BASE FLASHINGS / EDGE METAL

All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and the manufacturer. Acceptance shall only be for specific locations on specific dates. If any water enters under the newly completed roofing due to incomplete flashings, the affected area shall be removed and replaced at the Applicator's expense.

- A. Clad metal flashings shall be formed and installed per the Detail Drawings.
  - 1. All metal flashings shall be fastened into solid wood nailers with two rows of post galvanized flat head annular ring nails, 4 inches (100 mm) on center staggered. Fasteners shall penetrate the nailer a minimum of 1 inch (25 mm).
  - 2. Metal shall be installed to provide adequate resistance to bending and allow for normal thermal expansion and contraction.
- B. Adjacent sheets of Clad shall be spaced ¼ inch (6 mm) apart. The joint shall be covered with 2-inch (50 mm) wide aluminum tape. A 4-inch minimum (100 mm) wide strip of flashing membrane shall be hot-air welded over the joint. Each flashed joint shall be covered by a clad metal fascia plate to match the color of the clad edge metal. Install the clad fascia plate per Sarnafil standards.

### 3.11 WALL COPING METAL

- A. The substrate should be flat and level from front to back. Shim areas not level.
- B. The first cleat/chair set should be installed with the center line of the cleat set to the miter leg length and 24 in (300mm) from the end of a wall. Install cleats/chairs sets at all corners and ends first, then work along the wall to the center locating sets every 60" on center for walls less than 17 in and 40 in on center for walls 17 in – 32 in. Adjust the cleat location in the middle of a run to fit a short coping length. This procedure will provide a symmetrical appearance of the installed coping. Install metal gutter chair/concealed joint covers at joint locations. Hook coping face leg over the cleat face (front) leg and swing over the top. Snap the roof side (back) leg by pressing firmly down on the back edge directly over the cleat chair sets. Allow 1/8 in (3mm) gap, ¼ in (6mm) in colder weather, at each joint.

### 3.12 WALKWAY INSTALLATION

- A. Tread Walkway
  - 1. Roofing membrane to receive the Tread Walkway shall be clean and dry. Place chalk lines on deck sheet to indicate location of Walkway. Apply a continuous coat of 2170 adhesive to the deck sheet and the back of Walkway in accordance with manufacturer's technical requirements and press Walkway into place with a water-filled, foam-covered lawn roller. Clean the deck membrane in areas to be welded. Hot-air weld the entire perimeter of the Walkway to the membrane deck sheet. Check all welds with a rounded screwdriver. Re-weld any inconsistencies. **Important:** Check all existing deck membrane seams that are to be covered by Walkway with rounded screwdriver and re-weld any inconsistencies before Walkway installation. Do not run Walkway over Bars.

### 3.13 TEMPORARY CUT-OFF

- A. All flashings shall be installed concurrently with the roof membrane to maintain a watertight condition as the work progresses. All temporary waterstops shall be constructed to provide a 100% watertight seal. The stagger of the insulation joints shall be made even by installing

partial panels of insulation. The new membrane shall be carried into the waterstop. The waterstop shall be sealed to the deck and/or substrate so that water will not be allowed to travel under the new or existing roofing. The edge of the membrane shall be sealed in a continuous heavy application of sealant as described in Section 2.10. When work resumes, the contaminated membrane shall be cut out. All sealant, contaminated membrane, insulation fillers, etc. shall be removed from the work area and properly disposed of off site. None of these materials shall be used in the new work.

- B. If inclement weather occurs while a temporary waterstop is in place, the Applicator shall provide the labor necessary to monitor the situation to maintain a watertight condition.
- C. If any water is allowed to enter under the newly completed roofing, the affected area shall be removed and replaced at the Applicator's expense.

3.14 COMPLETION

- A. Prior to demobilization from the site, the work shall be reviewed by the Owner's Representative and the Applicator. All defects noted and non-compliances with the Specifications or the recommendations of the manufacturer shall be itemized in a punch list. These items must be corrected immediately by the Applicator to the satisfaction of the Owner's Representative and the manufacturer prior to demobilization.
- B. All Warranties referenced in this Specification shall have been submitted and have been accepted at time of contract award.

**END OF SECTION**

## SECTION 07 60 00

### FLASHING AND SHEET METAL

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Furnish materials and perform labor required to execute this work as indicated on the drawings, as specified and as necessary to comply with the Contract Documents, including, but not limited to, these major items:

- A. All metal wall flashings, related flashing, coping and caps.
- B. Flashing at curbed openings, and other miscellaneous areas where indicated on the drawings.
- C. Flashing flanges for roof drains and overflows.
- D. Flashing at parapet walls that receive roofing membrane.
- E. Flashing and metal covers at mechanical equipment platforms.
- F. Gutters and downspouts.
- G. Rain Water Leaders, Collectors and Scuppers.
- H. Shop and field priming, shop painting, galvanizing, screening, caulking, anchors and anchor straps, clips, etc.
- I. Shop drawings of all sheet metal work including expansion joints.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. Verify drawing dimensions with actual field conditions. Inspect related work and adjacent surfaces.
- B. Report to the Architect all conditions that prevent proper execution of this work.
- C. Mock up
  - 1. Provide mock up of metal coping cap at fiber cement siding location. Refer to specification 07 46 46 Fiber Cement Siding for additional information.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 23 Submittal Procedures.
- B. Shop Drawings: submit: all information required for fabrication, finishing and installation of this work in complete details.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with Section 01 60 00 Materials and Equipment.

1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00 Construction Facilities.
- B. Comply with Manufacturer's Standard Requirements.

1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

1.10 WARRANTY

- A. Provide Warranty in accordance with Section 01 78 36 Warranties and Bonds.
- B. Contractor guarantees the work covered by this specification against all defects in material and workmanship for a period of not less than five (5) years from the date the Owner records Notice of Completion.

**PART 2 – PRODUCTS**

2.01 MATERIALS

- A. Galvanized Sheet Metal: Conform to ASTM A525, thickness indicated or specified, but not less than 24-gauge. Zinc coating shall weigh not less than 1-1/2 ounces, or more than 1-1/2 ounces per square foot of surface covered.
- B. Solder: Standard Grade-A brand of 50:50 Alloy Lead-Tin, complying with ASTM B32. Name of manufacturer and grade designation shall be cast or die-marked on each bar.
- C. Solder Flux: Raw muratic acid for galvanized metal and zinc; resin for tin, lead, and tinned copper; and non-corrosive soldering salts for uncoated copper.
- D. Sheet Metal Fasteners: Rivets, nails, sheet metal screws, self-tapping screws, and stove bolts, of the type and size best adapted to the condition of use. Provide fasteners of the type specified or indicated.
  - 1. Use: galvanized steel, cadmium-plated steel or 300 Series alloy stainless steel.
  - 2. Pop rivets may be used for metal-to-metal connections when future disassembly is not required. Open-end type may be used for all applications except where watertight connections are required, in which case, use closed end type.
- E. Caulking Compound: Provide as specified under Section 07 90 00. Apply as recommended by the manufacturer; caulking compound of proper consistencies for gun and knife application as necessary.
- F. Shop Prime Coat: Rust-Oleum Corporation. Apply #3202 to 1/2 mil wet coating thickness, #3268 to 1-mil dry coating thickness or provide primer as specified under Section 09 90 00.
- G. Shop Color Coat: Pre-coat in shop with coating of color to match adjoining surfaces.

**PART 3 – EXECUTION**

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Correct conditions detrimental to timely and proper completion of the Work.
- C. Do not proceed until unsatisfactory conditions are corrected.
- D. Beginning of installation means acceptance of conditions.

### 3.02 FABRICATION AND ASSEMBLY

- A. Workmanship: Fabricate and finish metal work in a first-class manner in accordance with best trade practices with all joints and corners accurately machined, filed and fitted, and rigidly framed together and connected. Carefully match components to produce perfect continuity of line and design. Make joints and connections in exterior face metal watertight, using approved scaling materials and methods of assembly. Fit faces of metal in contact with hairline joints, except as otherwise indicated or required for expansion or fitting. Conceal fastenings, unless otherwise indicated. Conceal required reinforcements within the finished assembly.
- B. Expansion and Contraction: Form and fabricate work to adequately provide for thermal expansion and contraction and building movement in the completed work, without over-stressing the materials, breaking connections, or producing wrinkles and distortion in finished surfaces. Finish sheet metal work water and weathertight throughout.
- C. Attachment Clips: Where subject to thermal expansion and contraction, attach members with clips to permit movement without damage to the installation, or provide slotted or over-size holes with washers where appearance is not critical, as approved by the Architect.
- D. Lock Seams: Make lock seam work flat and true to line; sweat full of solder except where installed to permit expansion and contraction. Lap flat lock seams, and lap seams where soldered, according to pitch but in no case less than 4". Make seams in direction of flow. Fill expansion joints with sealant. Plane surfaces shall be free of buckles. Provide reinforcement as necessary. Cleat and fasten substantially on approximately eight-inch centers. All cap flashing and gutter seams to be flat lock seams.
- E. Soldering: Thoroughly clean and tin material prior to soldering. Solder with heavy coppers of blunt design, properly tinned before use. For flat seam work they shall not weight less than ten pounds per pair, and for other work not less than size pounds per pair. Solder slowly with well-heated coppers, heating the seams thoroughly and completely filling them with solder. Finish surfaces neatly, full flowing and smooth. Wash acid flux thoroughly with a soda solution after soldering and completely remove soldering flux on exposed surfaces.
- F. Welding: Conform to the requirements of AWS "Standard Code for Arc and Gas Welding". Perform welding in a manner resulting in strong, durable, tight, flush, smooth, and clean joints. Weld sheet steel to produce full and complete fusion welds without inducing locked-in stresses in the metal or surface distortions. Welding on exposed surfaces shall be ground smooth and flush and finished to match adjacent surfaces.
- G. Caulking: Where indicated, caulk joints in sheet metal work and between sheet metal work and adjacent construction with polysulfide sealing compound. Apply in accordance with Caulking and Sealants Section.
- H. Coping: Shall be attached to top of parapets in strict conformance with the latest written specifications of the Sheet Metal Industry Fund of Los Angeles, and as indicated on the drawings.
- I. All sheet metal work shall be examined carefully the Contractor, Owner and Architect and if necessary, tested. The Contractor shall make all repairs to damaged items as a result of this testing, leaving them in a condition satisfactory to the Architect.

**END OF SECTION**



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## SECTION 07 81 00

### SPRAY APPLIED FIREPROOFING

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract requirements and Division 1, General Conditions apply to this section.

##### 1.02 SCOPE OF WORK

- A. Provide materials, labor, and equipment necessary to install fireproofing as shown on the drawings and as specified herein, in accordance with contract documents.
- B. Related Sections
  - 1. 01 45 29 – Testing Laboratory Services
  - 2. 05 12 00 – Structural Metal Framing
  - 3. 07 84 00 – Firestopping
  - 4. 09 29 00 – Gypsum Board

##### 1.03 STANDARDS AND REFERENCES

- A. American Society for Testing and Materials (ASTM)
  - 1. E84 Surface Burning Characteristics
  - 2. E119 Fire Tests of Building Construction
  - 3. E605 Thickness and Density
  - 4. E736 Cohesion / Adhesion
  - 5. E759 Deflection
  - 6. E760 Impact on Bonding
  - 7. E767 Compressive Strength
  - 8. D790 Flexural Properties
  - 9. E859 Air Erosion
  - 10. E937 Corrosion of Steel
- B. Underwriters Laboratories, Inc. Fire Resistance Directory (UL 263 / ASTM E119).
- C. American Iron and Steel Institute, Designing Fire Protection for Steel Columns.

##### 1.04 QUALITY ASSURANCE

- A. Application of fireproofing shall be performed by a qualified applicator acceptable to the Carboline Company, St. Louis, MO.
- B. A Certified Installation Certificate must be completed and submitted at end of project.
- C. Provide materials and construction for hourly ratings listed in the Underwriters Laboratories, Inc. Fire Resistance Directory or as calculated by the American Iron and Steel Institute formula.
- D. Field constructed mock-up: Apply sample section to representative substrates on site. Mock-up should include primer, fireproofing at required thickness, density, and finished surface, and all finish coatings.
- E. Coordinate application of fireproofing with related work specified in other sections to comply with the following requirements:

1. Prevent deterioration due to exposure to unfavorable environmental conditions.
2. Protect fireproofing from abrasion and other damage likely to occur during construction operations after its application.
3. Install fireproofing prior to installation of enclosing or concealing work, allowing sufficient time for inspection, testing, and correction of defective fireproofing.

1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: Submit manufacturer's current Product Data and Application Instructions.
- C. Fireproofing manufacturer's certification that the materials to be supplied comply with the specifications and are suitable for the use intended.
- D. Fireproofing manufacturer's certification that the minimum performance standards as required under Section 2.01-A can be met and test reports supplied as requested.
- E. Schedule of Underwriters Laboratories, Inc. designs or American Iron and Steel Institute calculations to achieve the required hourly ratings.
- F. At completion of project, Certified Installation Certificate.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Material shall be delivered in original unopened packages, identified as to manufacturer and type, bearing the proper Underwriters Laboratories, Inc. label for fire resistance construction.
- B. Material shall be stored above ground, kept dry until ready for use. Materials shall be used prior to expiration date.

1.08 PROJECT CONDITIONS

- A. Minimum application temperature for air and substrate must be 40°F. If required for project progress, General Contractor shall provide enclosures with heat to maintain temperatures.
- B. General Contractor shall provide ventilation for proper drying of the fireproofing during and after its application. In poorly ventilated areas, forced air shall be used to achieve a total air exchange of four times per hour until the material is substantially dry.
- C. After application, fireproofing must be protected from running water or rain for 24 hours at 70°F or longer at lower temperatures.

1.9 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

## **PART 2 - PRODUCTS**

2.01 MATERIALS

- A. Cementitious fireproofing shall be applied to provide compliance with all drawings, specifications, and the following performance criteria:
  1. Dry Density: The in place density shall be measured in accordance with ASTM E605. Average and individual minimum density shall be 19/18 pcf respectively.
  2. Bond Strength: When tested in accordance with ASTM E736 over steel, fireproofing shall have a minimum bond strength of 1000 psf according to IBC code requirements.

3. Compressive Strength: Fireproofing shall achieve an average value of 38,448 psf when tested in accordance with ASTM E761.
  4. Deflection Resistance: Material shall not crack or delaminate from the surface when tested by ASTM E759.
  5. Corrosion: Material shall show 0.00 gm/mm<sup>2</sup> of corrosion when tested by ASTM E937.
  6. Impact Resistance: Material shall not crack or delaminate from the surface when tested by ASTM E760.
  7. Surface Burning Characteristics: Maximum flame spread and smoke development shall be 0 and 0 when tested under ASTM E-84.
- B. Fireproofing shall have been tested by Underwriters Laboratories, Inc. in accordance with the procedures of UL 263 / ASTM E119.
  - C. Fireproofing shall be investigated for interior use by Underwriters Laboratories, Inc.
  - D. Fireproofing shall be free of asbestos, mineral fibers, polystyrene, or other known materials which may be considered hazardous either during mixing, application curing, or chemical release in a fire.
  - E. Mix water shall be potable and free from such amounts of mineral or organic substances that would affect application or set of material.

## 2.02 ACCESSORIES

Provide accessories to comply with manufacturer's recommendations and to meet fire resistance design and code requirements. Such accessories include, but are not limited to, any required or optional items such as bonding agents, mechanical attachments; and application aids such as metal lath.

# **PART 3 - EXECUTION**

## 3.01 EXAMINATION

- A. All surfaces to be fireproofed shall be cleaned to the satisfaction of the applicator. Surface preparation shall be the responsibility of the steel fabricator, General Contractor, or trade effecting improper adhesion.
- B. Primed steel must follow the current Underwriters Laboratories, Inc. application requirements for bond and/or mechanical attachment.
- C. Unprimed steel must follow the application requirements of Carbolite Company, St. Louis, MO.
- D. Verify that objects which will penetrate fireproofing such as clips, hangers, support sleeves, etc. are securely attached to the substrate.
- E. Verify that substrates are not obstructed by ducts, piping, equipment, or other construction which might interfere with fireproofing application. If obstruction(s) are evident, General Contractor to have responsible trade remove obstruction until fireproofing is completed in the area.
- F. Do not proceed with fireproofing application until all unsatisfactory conditions have been corrected.

## 3.02 PREPARATION

- A. Clean substrates, removing dirt, dust, oil, grease, loose material, incompatible primers, or other substances which may impair bonding of fireproofing to the substrate.
- B. Where required, install metal lath and/or reinforcing mesh per the Underwriters Laboratories, Inc. and Carbolite Company design and application requirements.
- C. Provide drop cloths, masking, or other satisfactory protection for surfaces not to receive fireproofing to prevent damage from overspray.

3.03 APPLICATION

- A. Comply with manufacturers current instructions for equipment and application procedures.
- B. Apply fireproofing in thickness and density required to achieve fire resistance ratings.
- C. Finish surface shall be (as sprayed).

3.04 FIELD QUALITY CONTROL

- A. At the owner's expense, the engineer/architect may select an independent testing laboratory to sample and verify the thickness and density of the fireproofing in accordance with provisions of ASTM E605. Fireproofing for density may be sprayed or trowelled in separate, designated containers to minimize patching at site.
- B. Results of these tests shall be made available to all concerned at the completion of each floor or area.

3.05 PROTECTION

- A. Coordinate installation of fireproofing with other trades in order to minimize the need to cut or remove fireproofing. As other trades successfully complete installation of their work, maintain protection of fireproofed portions of the structure by repairing any areas which have been removed or damaged prior to concealment of fireproofing by other work.
- B. Fireproofing applicator shall post SLIPPERY WHEN WET signs in areas of active application. If applicable, the General Contractor shall install barriers to prevent other trades from entering the application area till the material dries or is cleaned.
- C. Areas subject to overspray that are to remain permanently exposed as detailed on the drawings, must be covered by drop cloths or other satisfactory protection to prevent contact with fireproofing material.

3.06 PATCHING AND REPAIR

Fireproofing damaged by other trades shall be repaired by fireproofing applicator and paid for by the trade(s) causing damage.

3.07 CLEANING

- A. Except as detailed, surfaces are to be left in a scraped clean condition.
- B. At completion of fireproofing work, application equipment shall be removed from site.

3.08 SCHEDULE

Fire resistance rating in hours shall be per Plans and include 1-HR and 2-HR rated Floor Assemblies and Structural Members.

**END OF SECTION**

## SECTION 07 81 23

### INTUMESCENT FIREPROOFING

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 WORK INCLUDED

- A. This specification covers labor, materials, equipment, and application necessary for, and incidental to, the complete and proper installation of intumescent fire protection for application to steel structures and supports in accordance with all applicable requirements of contract documents.
- B. This specification shall be supplemented by the applicable requirements of building codes, insurance rating organizations and all other authorities having jurisdiction.

##### 1.03 RELATED WORK

- A. Specified elsewhere:
  - 1. 01 10 00 – Summary of Work
  - 2. 01 45 29 – Testing Laboratory Services
  - 3. 05 12 00 – Structural Framing
  - 4. 05 50 00 – Metal Fabrications
  - 5. 07 84 00 – Firestopping
  - 6. 09 90 00 – Painting

##### 1.04 QUALITY ASSURANCE

- A. Application of fireproofing shall be performed by a qualified applicator acceptable to the Carboline Company, St. Louis, MO.
- B. A Certified Installation Certificate must be completed and submitted at end of project.
- C. Provide materials and construction for hourly ratings listed in the Underwriters Laboratories, Inc. Fire Resistance Directory or as calculated by the American Iron and Steel Institute formula.
- D. The intumescent fire resistive material shall be manufactured under the Follow-Up Service program of UL/ULC and/or Intertek and bear the UL/ULC and/or Intertek label (mark).
- E. Field constructed mock-up: Apply sample section to representative substrates on site. Mock-up should include primer, fireproofing at required thickness, density, and finished surface, and all finish coatings.
- F. The product shall be approved by the architect and applicable authorities having jurisdiction.

##### 1.05 REFERENCES

- A. American Society for Testing and Materials (ASTM)
  - 1. E84 Surface Burning Characteristics
  - 2. E119 Fire Tests of Building Construction
  - 3. D2240 Durometer Hardness
  - 4. D2794 Impact Resistance
  - 5. D4060 Abrasion Resistance
  - 6. D4541 Bond Strength

- B. Underwriters Laboratories, Inc. Fire Resistance Directory (UL 263 / ASTM E119).
- C. CAN/ULC-S101 Standard Methods of Fire Endurance Tests of Building Construction and Materials
- D. Steel Structures Painting Council (SSPC) Surface Preparation Standards
- E. American Iron and Steel Institute, Designing Fire Protection for Steel Columns.
- F. AWCI Technical Manual 12-B "Standard Practice for the Testing and Inspection of Field Applied Thin-Film Intumescent Fire-Resistive Materials; an Annotated Guide", Latest Edition

#### 1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's current Product Data and Application Instructions.
- B. Fireproofing manufacturer's certification that the materials to be supplied comply with the specifications and are suitable for the use intended.
- C. Fireproofing manufacturer's certification that the minimum performance standards as required under Section 2.01-A can be met and test reports supplied as requested.
- D. Schedule of Underwriters Laboratories, Inc. designs or American Iron and Steel Institute calculations to achieve the required hourly ratings.
- E. At completion of project, Certified Installation Certificate.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the project in manufacturer's unopened packages, fully identified as to trade name, type and other identifying data. Packaged materials shall bear the appropriate labels, seals and UL label (mark) for fire resistive ratings and shall be stored at temperatures between 32° F (0° C) and 100° F (38° C), in a dry interior location away from direct sunlight.
- B. Materials shall be used prior to expiration date.

#### 1.08 SITE CONDITIONS

- A. When the temperature at the job site is less than 41° F (5° C), a minimum substrate and ambient temperature of 41° F (5° C) shall be maintained prior to and during application. If necessary for job schedule, the General Contractor shall provide enclosures and heat to maintain proper temperatures and humidity levels in the application areas.
- B. General Contractor shall provide ventilation for proper drying of the fireproofing during and after its application. In poorly ventilated areas, forced air shall be used to achieve a total air exchange of four times per hour until the material is substantially dry.
- C. Relative humidity shall not exceed 85% throughout the total period of application and drying for the intumescent fire resistive material, and must not exceed 85% throughout the application and drying for the protective decorative topcoat.

#### 1.09 SEQUENCING

- A. Coordinate application of fireproofing with related work specified in other sections to comply with the following requirements:
  - 1. Prevent deterioration due to exposure to unfavorable environmental conditions.
  - 2. Protect fireproofing from abrasion and other damage likely to occur during construction operations after its application.
  - 3. The installation of piping, ducts, conduit or other suspended equipment shall not commence until the application of the thin-film fire resistive material is complete in that area.
  - 4. Install fireproofing allowing sufficient time for inspection, testing, and correction of defective fireproofing.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

- A. Basis of Design: Intumescent coating, Thermo-SORB VOC, as manufactured by Carboline Company, St. Louis, MO and primer as recommended by manufacturer or Architect approved equal.
- B. Compatible metal primer shall be approved and applied in full accordance with the primer manufacturer's written instructions.
- C. The intumescent fire resistive material shall be supplied by Carboline. Intumescent fire resistive material shall be applied in accordance with drawings and/or specifications, and shall have been tested in accordance with the procedures of UL 263 or ASTM E119 or CAN/ULC-S101, and reported by Underwriters Laboratories, Inc., Underwriters Laboratories of Canada or Intertek.
- D. Intumescent fireproofing shall be applied to provide compliance with all drawings, specifications, and the following performance criteria:
  - 1. ASTM E84 (UL723, CAN/ULC-S102): Surface Burning Characteristics of Building Materials. Flame Spread Maximum: 0 and Smoke Developed Maximum: 0.
  - 2. ASTM D2240: Durometer Hardness (Shore D Only). Minimum: 70 Shore D.
  - 3. ASTM D2794: Impact Resistance. Intrusion minimum: 0.16 ft. lbs/in.
  - 4. ASTM D4541: Bond Strength. Minimum: 200 psi (1,378 kPa).
- E. Fireproofing shall be investigated for interior use by Underwriters Laboratories, Inc.
- F. Fireproofing shall be free of asbestos, mineral fibers, polystyrene, or other known materials which may be considered hazardous either during mixing, application curing, or chemical release in a fire.
- G. Topcoat materials shall be as required for color-coding, aesthetics or additional surface protection, approved by the thin-film fire resistive material manufacturer and applied in full accordance with the coating manufacturer's written instructions.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. All surfaces to receive thin-film fire resistive material shall be clean, dry and free of oil, grease, loose mill scale, dirt, dust or other materials which would impair bond of the thin-film fire resistive material to the surface. Any cleaning of the surfaces to receive fire resistive material shall be the responsibility of the General Contractor or steel erector, as outlined in the structural steel section.
- B. Confirm compatibility of surfaces to receive thin-film fire resistive material. Steel surfaces shall be primed with a compatible primer approved by the thin-film fire resistive material manufacturer.
- C. Verify that objects which will penetrate fireproofing such as clips, hangers, support sleeves, etc. are securely attached to the substrate.
- D. Verify that substrates are not obstructed by ducts, piping, equipment, or other construction which might interfere with fireproofing application. If obstruction(s) are evident, General Contractor to have responsible trade remove obstruction until fireproofing is completed in the area.
- E. Do not proceed with fireproofing application until all unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Clean substrates, removing dirt, dust, oil, grease, loose material, incompatible primers, or other substances which may impair bonding of fireproofing to the substrate.



- B. Provide drop cloths, masking, or other satisfactory protection for surfaces not to receive fireproofing to prevent damage from overspray.

### 3.03 APPLICATION

- A. The thin-film fire resistive material shall be applied at the required dry film thickness per the appropriate design number guidelines and manufacturers written application instructions.
- B. Comply with manufacturers current instructions for equipment and application procedures.
- C. Apply fireproofing in thickness required to achieve fire resistance ratings.
- D. Before proceeding with the work, the applicator shall apply the thin-film fire resistive material to a section witnessed by the architect's or owner's representative. The application shall be subject to their approval and shall be used as a guide for texture and thickness of the finished work.

### 3.04 FIELD QUALITY CONTROL

- A. In addition to continuous Wet Film Thickness checks performed by applicator during application, the installed intumescent material shall be inspected by a qualified independent testing laboratory for thickness in accordance with the AWCI Technical Manual 12-B "Standard Practice For The Testing and Inspection Of Field Applied Thin-Film Intumescent Fire-Resistive Materials; an Annotated Guide", Latest Edition, before application of the topcoat.
- B. The results of the above tests shall be made available to all parties at the completion of each area and approved prior to the application of topcoat.

### 3.05 PROTECTION

- A. Coordinate installation of fireproofing with other trades in order to minimize the need to cut or remove fireproofing. As other trades successfully complete installation of their work, maintain protection of fireproofed portions of the structure by repairing any areas which have been removed or damaged.
- B. If applicable, the General Contractor shall install barriers to prevent other trades from entering the application area till the material dries.
- C. Areas subject to overspray that are to remain permanently exposed as detailed on the drawings, must be covered by drop cloths or other satisfactory protection to prevent contact with fireproofing material.

### 3.06 PATCHING AND REPAIR

- A. All patching of and repair to thin-film fire resistive material, due to damage by other trades, shall be performed under this section and paid for by the trade responsible for the damage. Patching shall be performed by an applicator with expertise in the installation of fire resistive or similar materials. Repair shall be in accordance with design number guidelines and manufacturers written application instructions.

### 3.07 CLEANING

- A. Upon completion of installation, all excess material, overspray and debris shall be cleared and removed from the job site.
- B. At completion of fireproofing work, application equipment shall be removed from site.

### 3.08 SCHEDULE

Fire resistance rating in hours shall be the following:

	Hour	Rest.	Unrest.
Columns, Supporting Floor			1
Columns, Supporting Roof			1

### **END OF SECTION**

## SECTION 07 84 00

### FIRE STOPPING

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Work included: Provide firestopping where indicated on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. It is the intent of this section of the specifications to establish a single, competent source to be responsible for providing all labor, materials, products, equipment and services, to supply and install the firestopping and smoke seal work for the entire project, at the following locations, as indicated on the drawings:
  - 1. Openings in fire rated walls, floors and roofs both empty and those containing penetrations such as cables, conduits, cable trays, pipes, ducts and similar penetrating items.
  - 2. Gaps between fire-rated floor slabs and exterior curtain walls.
  - 3. Gaps between fire-rated walls and exterior curtain walls.
  - 4. Gaps located within expansion joints.
  - 5. Gaps between the tops of fire rated walls and underside of fire rated floor or roof assemblies.
  - 6. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.
  - 7. Openings at each floor level in fire rated shafts or stairwells.
- C. System Description:
  - 1. Firestopping Materials: Provide firestopping system(s) of sufficient thickness, width and density to provide and maintain a fire resistance rating, as indicated on drawings and in accordance with UL.
  - 2. Provide a seal completely filling all annular spaces to prevent the passage of flame, smoke and gases through the opening in the fire separation in which it is installed.
  - 3. Material Compatibility: Provide materials which are compatible with all materials used in the system including materials used in or on penetrating items as well as all construction materials used in conjunction or contiguous with the system.
  - 4. Accessories: Provide components for each firestopping system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire resistance rated systems. Accessories include but are not limited to the following items:
    - a. Permanent forming/damming/backing materials
    - b. Temporary forming materials
    - c. Substrate primers
    - d. Collars
    - e. Steel sleeves

D. Related Work:

1. Openings through Floors and Walls:
  - a. Fire Rated: Metal sleeves for fire rated openings through floors and walls shall be provided under applicable mechanical and electrical specification sections.
  - b. Non-Rated: Non-rated openings through floors and walls shall be sealed under applicable mechanical and electrical specification sections.
2. Firestopping and smoke seals within mechanical (i.e. inside ducts, dampers) and electrical assemblies shall be sealed under applicable mechanical and electrical specifications sections and only in accordance with the equipment or device manufacturers' installation instructions. Firestopping and smoke seals around outside of such mechanical and electrical assemblies, where they penetrate fire rated separations, are the responsibility of this section.

1.03 STANDARDS AND REFERENCES

A. General:

1. ASTM E814 - Test Method of Fire tests of Through Penetration Firestops.
2. ANSI/UL 1479 - Fire Tests Of Through-Penetration Firestops
3. ANSI/UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems
4. ASTM E1966 – Standard Test Method for Fire-Resistive Joint Systems
5. ASTM E2307 – Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-Story Apparatus
6. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials
7. ASTM C616 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation
8. UL 2079 – Standard Test Method for Fire Resistance of Building Joint Systems
9. UL: Fire Resistance Directory, Volume 2.
10. ITS: Directory of Listed Products.
11. Factory Mutual, Approvals Guide

B. Regulatory Requirements

1. Conform to applicable local Building Codes for fire resistance ratings.
2. Provide materials, accessories and application procedures which have been listed by UL, or as tested by a nationally recognized independent testing agency in accordance with ASTM E814, ANSI/UL 1479, or ANSI/UL 2079 to achieve the required fire protection rating(s).

C. Environmental requirements:

1. Do not proceed with the installation of firestopping materials when temperatures or weather conditions exceed the manufacturer's recommended limitations for installation.
2. Ventilate solvent based and moisture-cure firestopping per firestopping manufacturer's instructions by natural means or, where this is inadequate, by forced air circulation.

1.04 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products of this Section with minimum ten (10) years documented experience, and having a quality management system that is registered as conforming to the requirements of ISO9001.
- B. Applicator: Company having a minimum of three (3) years of experience in the installation of materials specified herein on projects comparable to this project. The firm shall have the written authorization of the firestopping material manufacturer(s).

1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Manufacturer's Data: Submit manufacturer's specifications, installation instructions and product data for each material required. Include [UL], [WH], or [FM] tested systems or designs to show compliance with the Contract Documents.
- C. Shop Drawings: Submit shop drawings showing typical installation details including reinforcement, anchorage, fastenings and method of installation for each type of firestopping condition.
- D. Samples: If requested, submit samples of each type of firestopping systems, smoke seals and accessories. Indicate location where material/system shall be utilized.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply Section 01 66 00 Product Storage and Handling Requirements.
- B. Deliver materials to Site in manufacturer's sealed and labelled containers or packaging intact. Handle and store materials in accordance with manufacturer's instructions.

1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Sections 01 50 00.
- B. Comply with manufacturer's recommended requirements for temperature, relative humidity and substrate moisture content during application and, if required, curing of materials.
- C. Do not install firestopping system(s) until Work within opening has been completed. Coordinate with other applicable Sections. Schedule work of other trades so that firestopping applications can be inspected prior to being covered by subsequent construction.

1.09 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 – PRODUCTS**

2.01 ACCEPTABLE MANUFACTURERS

Provide firestopping silicone sealants, water-based sealants, intumescent sealant, mortars, mineral wool, or firestop devices from the following manufacturers:

- A. Basis of Design: A/D Fire Protection Systems Inc. Tel: (800) 263-4087. Website: [www.adfire.com](http://www.adfire.com)
- B. Owens Corning Thermafiber. Tel: (800) 294-7076. Website: [www.thermafiber.com](http://www.thermafiber.com)
- C. Or Architect approved equal.

## 2.02 MATERIALS

- A. Provide a complete system of asbestos-free firestop systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of [ASTM E814], [ANSI/UL 1479], or [ANSI/UL 2079] and listed by [UL], [WH], or [FM] and in addition are approved by jurisdictional authorities and the Consultant.
- B. A/D FIRE BARRIER Silicone Sealants: For use in: openings with penetrating items subject to high movement; multiple penetration systems; for combustible pipes up to 2-in. diameter; in control joints; in curtain wall joints; expansion joints; floor/wall joints; wall/wall joints; head of wall joints; and as a sealant for smoke barrier construction.
- C. A/D FIRE BARRIER Intumescent Caulk: For general use as a firestop sealant with: insulated pipes; pipes; electrical cables and conduit; ducts.
- D. A/D FIRE BARRIER Seal and Seal NS: Water based firestop sealants for use with: control joints; head of wall joints; floor/wall joints; wall/wall joints; multiple penetration systems; plumbing; mechanical; electrical; and where sprayed sealant application is required or desired.
- E. A/D FIRE BARRIER Mortar: For use in: large openings; static non-moving penetrations such as cable trays; for multiple penetration systems; electrical and communication bundles; conduits; non-combustible sleeves; and insulated pipes.
- F. A/D FIRE BARRIER Collars: For use in openings with single combustible pipe penetrations greater than 2-in. diameter.
- G. A/D FIRE BARRIER Pillows: For use in openings with: cable tray; multiple cable penetrations; where retrofitting of penetrating items is anticipated, and as a temporary fire stop system.
- H. Thermafiber Safing: For use in fire and smoke protection in perimeter fire containment systems between fire-rated floor slabs and exterior curtain walls, between fire-rated walls and exterior curtain walls, in floor and wall penetrations, construction joints, and other firestopping applications.
- I. Thermafiber TopStop: For use in Head-of-Wall construction between metal fluted floor/roof deck and top of fire-rated wall construction. For trapezoidal shaped flutes measuring 2" – 7" wide and depths up to 3".
- J. Fire stop system ratings: Comply with applicable Building Code requirements for locations and ratings.

## 2.03 ACCESSORIES

- A. Damming and backup materials, supports and anchoring devices: Non-combustible, to manufacturer's recommendations and in accordance with the tested system being installed as acceptable to jurisdictional authorities.
- B. Primers: As required by firestopping manufacturer and compatible with selected system and contiguous materials.
- C. Water: Potable.
- D. Firestopping for vertical (wall) applications: Non-sag caulk or spray grade sealants, Mortar, Collars or Pillows.
- E. Firestopping for horizontal (floor) applications: Non-sag caulk or self-levelling or spray grade sealants, Mortar, Collars or Pillows.
- F. Firestopping for overhead applications: Non-sag caulk or spray grade sealants or Mortar.
- G. Safing Clips: Z-shaped clips formed from galvanized steel.
- H. Tape: Pressure sensitive masking tape as recommended by the firestopping manufacturer.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Examine substrates, openings, voids, adjoining construction and conditions under which the Work is to be installed. Confirm compatibility of surfaces scheduled to receive firestopping.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Verify that penetrating elements are securely fixed and properly located with the proper space allowance between penetrations and surfaces of openings.
- E. Do not proceed with Work until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of conditions.

### **3.02 PREPARATION**

- A. Surfaces to receive firestopping shall be free of dirt, dust, grease, oil, rust, loose materials, form release agents, frost, moisture or any other matter which would impair the bond of firestopping material to the substrate of penetrating item(s).
- B. For sealants and caulks, prime substrates in accordance with manufacturer's written instructions or recommendations. Confine primers to areas of bond; do not allow spillage or migration onto exposed surfaces.
- C. Do not apply firestopping and smoke seals to surfaces previously painted or treated with sealers, curing compounds, water repellent or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- D. Ensure that anchoring devices, back-up materials, clips, sleeves, supports and other related materials used in the actual fire tests are provided.
- E. Mask where necessary to prevent firestopping materials from contacting adjoining surfaces that will remain exposed upon completion of Work. Remove tape as soon as it is possible to do so without disturbing firestopping seal with substrates.
- F. Installation is not to proceed until submittals have been completed.

### **3.03 INSTALLATION**

- A. Manufacturer's Instructions: Comply with [UL], [WH] or [FM] Listings and manufacturer's instructions for the type of material and condition of opening in each case. Consult with the manufacturer's technical representative to determine proper procedure for conditions not fully covered by printed instructions. Record in writing any oral instructions received, with copy to manufacturer.
- B. Install firestopping with sufficient pressure to properly fill and seal openings to ensure an effective smoke seal. Tool or trowel exposed surfaces. Remove excess firestopping material promptly as the Work progresses and upon completion.
- C. Damming: Provide leak-proof dams as required to seal openings and contain liquid sealants, putty or mortar until cured. Install damming in accordance with manufacturer's instructions.
- D. Damming Boards: Install forming/damming materials and other accessories of type required to support fill materials during their application and in the position needed to produce the shapes and depths required to achieve fire ratings of through-penetration fire stop systems.
  - 1. Combustible Type: For temporary dams only. Remove after firestopping material has cured.
  - 2. Non-Combustible Type: For temporary or permanent dams. Provide non-combustible type wherever damming material cannot be removed after applying firestopping materials.

- E. Void Filler: Use materials recommended by the firestopping manufacturer to seal gaps created by non-combustible type damming boards and to seal around cables, conduits, pipes and where void filler material becomes part of the fire rated assembly.
- F. Sealant: Install damming material or mineral wool as required. Apply sealant so air voids are not present and sealant is in full contact with penetrating items. Tool sealant to ensure substrate contact. Remove excess sealant in accordance with manufacturer's recommendations.
- G. Mortar: Install damming material as required. Mix mortar in strict accordance with manufacturers instructions. Pump, trowel or hand pack mortar through openings to minimum thickness as recommended by manufacturer and as listed by [UL], [WH] or [FM], to achieve required fire rating.
- H. Firestopping Mineral Wool: Install firestopping by compressing material to the minimum required by [UL], [WH] or [FM] listing. Apply firestopping in sufficient thickness, depth and density so as to achieve the required fire resistance rating. Use impaling or safing clips to support and secure firestopping where required by tested system.

3.04 FIELD QUALITY CONTROL

- A. Notify Consultant when completed installations are ready for inspection prior to concealing or enclosing an area containing firestopping materials.
- B. Arrange for inspections by the Owners independent inspection and testing company, appointed and paid for by Owner.
- C. Following field inspections, provide all repair as required to ensure compliance with the Contract Documents.

3.05 CLEANING AND PROTECTION

- A. Upon completion of this work, remove all materials, equipment and debris from the site.
- B. Leave work area and adjacent surfaces in a condition acceptable to the Consultant.
- C. Leave installed work with sufficient protection to enable it to remain untouched until project turnover.

END OF SECTION

## SECTION 07 90 00

### JOINT PROTECTION

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK

Work included: Throughout the work, seal and caulk joints where shown on the Drawings and elsewhere as required to provide a positive barrier against passage of moisture and passage of air.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. Conform to Sealant and Waterproofers Institute requirements for materials and installation.
- B. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.
- C. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Submit product data:
  - 1. For each sealant product indicated provide manufacturer's technical data, tested physical and performance properties, dimensioned drawings, and other data needed to prove compliance with the specified requirements.
  - 2. Manufacturer's recommended installation procedures which, when accepted by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.
- C. Samples:
  - 1. Samples for Initial Selection: Three color charts showing manufacturer's standard range of colors available for each product exposed to view.
  - 2. Samples for Verification: Three strips of cured sealants 1/2 inch by 6 inch (13mm diameter by 150 mm).

##### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01 66 00 Product Storage and Handling Requirements.
- B. Deliver products in original factory packaging bearing identification of product, manufacturer, and batch number. Provide Safety Data Sheets for each products.
- C. Store products in a location from freezing, damage, construction activity, precipitation, and direct sunlight per manufacturer's recommendations.
- D. Condition products to approximately 60 degrees F (16 degrees C) to 70 degrees F (21



degrees C) for use per manufacturer's recommendations.

E. Handle products with appropriate precautions and care as stated on Safety Data Sheet.

1.08 PROJECT CONDITIONS

A. Do not use products under conditions of precipitation, or in inclement or freezing weather. Verify that substrates are clean, dry and frost-free. Use appropriate measures for protection and supplementary heating to ensure proper curing conditions per manufacturer's recommendations if application during inclement weather occurs.

1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with 01 77 00 Project Closeout.

1.10 WARRANTY

A. Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

B. Warranties listed in this Section shall be in addition to, and not a limitation of other rights the owner may have under the contract documents.

C. The guarantee specified herein shall include warranties against leakage, hardening, cracking, crumbling, melting, running, shrinking or staining adjacent surfaces.

D. Contractor Guarantee: Contractor guarantees the work covered by this specification against all defects in material and workmanship for a period of not less than five (5) years from the date of Substantial Completion.

**PART 2 – PRODUCTS**

2.01 SEALANTS

A. Except as specifically otherwise accepted by the Architect, use only the types of sealants described as follows:

1. One component polyurethane sealant, moisture curing, low modulus, FS TT-S-0023OC, Type II, Class A, ASTM-C-920, Class 50, for vertical and horizontal joints in connection with all building materials. Do not use in traffic areas. Minimum 1/4" joint; maximum 1-1/4" x 3/8"d.
  - a. Dymonic 100 by Tremco
  - b. MasterSeal NP1 by BASF Master Builders
  - c. DynaTrol I-XL Hybrid by Pecora Corporation
2. One-part silicone sealant, moisture curing, low modulus, FS TT-S-0023OC, Type II, Class A, FS TT-S-001543A, Class A, for vertical and horizontal joints in connection with aluminum, glass and concrete materials which require greater movement capabilities. Do not use in traffic areas. Minimum joint 1/4" x 3/16"d; maximum 1" x 1/2"d.
  - a. Spectrem 1 by Tremco
  - b. Dowsil 790 by Dow
  - c. 890NST Silicone by Pecora Corporation
3. One-part silicone sealant, medium modulus, neutral cure, FS S-0023OC, Type II, Class A, FS TT-S-001543A, Type II, Class A, ASTM C920, Class 50, for vertical and horizontal joints in connection with non-porous surfaces such as aluminum, glass, tile, laminated plastic and concrete. Do not use in traffic areas.
  - a. Spectrem 2 by Tremco

- b. Dowsil 795 by Dow
  - c. 895NST Silicone by Pecora Corporation
- 4. Multi-Component polyurethane sealant, FS TT-S-00227E, Type I, Class A, ASTM C920 for horizontal joints in traffic areas. Minimum 3/8" wide, depth to be 3/8" to 1/2" - use primer.
  - a. THC-901 by Tremco
  - b. DynaTrol II-SG or Dynatred by Pecora Corporation
- 5. One-part translucent silicone sealant, medium modulus, neutral curing, FS TT-S-00230C, Type II, Class A, FS TT-S-001543A, Type II, Class A, for vertical joints in connection with butt glazing.
  - a. 895 NST by Pecora
  - b. SCS2800 Silglaze II by Mumentive
- 6. One-part mildew resistant silicone sealant meeting requirements of FDA Regulation 21 CFR 177.2600, for vertical and horizontal joints in connection with non-porous applications as sealing around bathroom fixtures, shower-tub enclosures, sinks and urinals.
  - a. Dowsil 786 by Dow
  - b. SCS1700 Sanitary by Mumentive
  - c. 898NST Silicone or 860 Silicone by Pecora Corporation
- 7. One-part siliconized acrylic latex polymer caulk, ASTM C834, for interior horizontal and vertical joints in connection with window and door buck perimeters, interior wall surfaces, etc.
  - a. AC-20 + Silicone by Pecora
  - b. Acrylic Latex by Tremco
- 8. Security Sealants
  - a. One part, non-sag, tamper resistant security sealant, FS TT-S-00230C, Type II, Class B, ASTM C920 for doors and windows.
    - i. DynaFlex SC by Pecora
    - ii. MasterSeal CR 195 by BASF Master Builders.
  - b. Multi-component, rigid, high-solids, high modulus epoxy resin security sealant, ASTM C881, Type I and III, Grade 3, Classes B & C.
    - i. DynaPoxy EP-1200 by Pecora
    - ii. Sikadur -31 BY Sika USA
- 9. Roof Penetrations: Use asphalt mastic conforming to ASTM D491.
- 10. For other services, provide products especially formulated for the proposed use and accepted in advance by the Architect.

**B. Colors:**

- 1. The Architect will select Colors for each sealant installation to match adjacent finishes from a standard color list normally available from the specified manufacturers.
- 2. Should a matching standard color not be available from the accepted manufacturer except at additional charge, the Contractor shall provide such colors at no additional cost to the Owner.

3. In concealed installations, and in partially or fully exposed installations where so accepted by the Architect, use standard gray or black sealant.

## 2.02 PRIMERS

Use only those primers that are: non-staining, have been tested for durability on the surfaces to be sealed, and are specifically recommended for this installation by the manufacturer of the sealant used.

## 2.03 BACKUP MATERIALS

A. Use only those backup materials that are specifically recommended for this installation by the manufacturer of the sealant used, which are non-absorbent, and which are non-staining.

B. Acceptable types include:

1. Closed-cell resilient urethane or polyvinyl chloride foam;
2. Closed-cell polyethylene foam;
3. Closed-cell sponge of vinyl or rubber;
4. Polychloroprene tubes or beads;
5. Polyisobutylene extrusions;
6. Oil-less dry jute.

C. Preformed support strips for ceramic tile control joint and expansion joint work: Use polyisobutylene or polychloroprene rubber.

## 2.04 BOND-PREVENTATIVE MATERIALS

Use only one of the following as best suited for the application, and as recommended by the manufacturer of the sealant used:

1. Polyethylene tape, pressure-sensitive adhesive, with the adhesive required only to hold tape to the construction materials as indicated;
2. Aluminum foil complying with MIL-A-148E;
3. Wax paper complying with Fed. Spec. UU-P-270.

## 2.05 JOINT PACKING

Shall be installed in all joints to receive sealant. Material shall be a resilient type such as closed cell PVC foam or as recommended by the manufacturer. Oakum or other types of absorptive materials shall not be used as packing material.

## 2.06 OTHER MATERIALS

A. For masking around joints, provide masking tape complying with Fed. Spec. UU-T-106c.

B. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the acceptance of the Architect.

# **PART 3 – EXECUTION**

## 3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that specified items may be installed in accordance with the approved design.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.

E. Beginning of installation means acceptance of conditions.

### 3.02 PREPARATION

#### A. Concrete and ceramic tile surfaces:

1. Install only on surfaces that are dry, sound, and well brushed, wiping free from dust.
2. At open joints, remove dust by mechanically blown compressed air if so required.
3. Use solvent to remove oil and grease, wiping the surfaces with clean rags.
4. Where surfaces have been treated, remove the surface treatment by sandblasting or wire brushing.
5. Remove laitance and mortar from joint cavities.
6. Where backstop is required, insert the approved backup material into the joint cavity to the depth needed.

#### B. Steel surfaces:

1. Steel surfaces in contact with sealant:
  - a. Sandblast as required to achieve acceptable surface for bonding.
  - b. If sandblasting is not practical, or would damage adjacent finish, scrape the metal or wire brush to remove mill scale.
  - c. Use solvent to remove oil and grease, wiping the surfaces with clean rags.
2. Remove protective coatings on steel by sandblasting or by using a solvent that leaves no residue.

#### C. Aluminum surfaces:

1. Remove temporary protective coatings, dirt, oil, and grease.
2. When masking tape is used for protective cover, remove the tape just prior to applying the sealant.
3. Use only such solvents to remove protective coatings as are recommended for that purpose by the manufacturer of the aluminum work, and which are non-staining.

### 3.03 INSTALLATION OF BACKUP MATERIAL

- A. Use only the backup material recommended by the manufacturer of the sealant used, and accepted by the Architect for the particular installation, compressing the backup material 25% to 50% to achieve a positive and secure fit.
- B. When using backup of tub or rod stock, avoid lengthwise stretching of the material. Do not twist or braid hose or rod backup stock.
- C. Interior and exterior joints where no backing has been provided or which is in excess of 3/4" deep shall be packed by this subcontractor with fiberglass or a suitable joint filler to reduce the depth to 1/2" maximum. Maximum movement: the width of the joint shall be at least four times its maximum movement.

### 3.04 PRIMING

- A. Use only the primer recommended by the manufacturer of the sealant, and accepted by the Architect for the particular installation, applying in strict accordance with the manufacturer's recommendations as accepted by the Architect.
- B. The priming of joints shall be by brush to reach all surfaces to which compound will be applied. Primer shall be provided on masonry, concrete and wood surfaces as recommended by sealant manufacturer. Primer shall not be applied to surfaces that will be exposed after caulking is completed.

### 3.05 BOND-BREAKER INSTALLATION

Provide an approved bond-breaker where recommended by the manufacturer of the sealant, and where directed by the Architect, adhering strictly to the installation recommendations as accepted by the Architect.

### 3.06 INSTALLATION OF SEALANTS

- A. Prior to start of installation in each joint, verify the joint type according to details on the Drawings, or as otherwise directed by the Architect, and verify that the required proportion of width of joint to depth of joint has been secured.
- B. Equipment:
  - 1. Apply sealant under pressure with power-actuated or hand gun, or by other appropriate means.
  - 2. Use guns with nozzle of proper size, and providing sufficient pressure to completely fill the joints as designed.
- C. Thoroughly and complete mask joints where the appearance of sealant on adjacent surfaces would be objectionable.
- D. Install the sealant in strict accordance with the manufacturer's recommendations as accepted by the Architect, thoroughly filling joints to the recommended depth.
- E. Tool joints to the profile shown on the Drawings, or as otherwise required if such profiles are not shown on the Drawings.
- F. Cleaning up:
  - 1. Remove masking tape immediately after joints have been tooled.
  - 2. Clean adjacent surfaces free from sealant as the installation progresses, using solvent or cleaning agent recommended by the manufacturer of the sealant used.
  - 3. The excess material shall be cleaned from the surfaces adjacent to the joint, following the caulking operation and the top of the compound deposit shall be left with a smooth even finish. No material is permitted on the exposed face of aluminum sections.

**END OF SECTION**

## SECTION 08 11 00

### METAL DOORS AND FRAMES

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

###### A. Section Includes:

1. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.
3. Louvers installed in hollow metal doors.
4. Light frames and glazing installed in hollow metal doors.

###### B. Related Sections:

1. Division 01 Section "General Conditions".
2. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
3. Division 08 Section "Flush Wood Doors".
4. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
5. Division 08 Section "Door Hardware".
6. Division 08 Section "Access Control Hardware".
7. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.

##### 1.03 STANDARDS AND REFERENCES

###### A. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
14. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
15. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
16. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.
  1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
  2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
  3. Smoke Control Door Assemblies: Comply with NFPA 105.
    - a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
- D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.
- E. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

1.06 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Include the following:
  - 1. Elevations of each door design.
  - 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
  - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 4. Locations of reinforcement and preparations for hardware.
  - 5. Details of anchorages, joints, field splices, and connections.
  - 6. Details of accessories.
  - 7. Details of moldings, removable stops, and glazing.
  - 8. Details of conduit and preparations for power, signal, and control systems.
- D. Samples for Verification:
  - 1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
  - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.08 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.09 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Building Information Modeling (BIM) Support: Utilize designated BIM software tools and obtain training needed to successfully participate in the Project BIM processes. All technical



disciplines are responsible for the product data integration and data reliability of their Work into the coordinated BIM applications.

#### 1.010 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
- B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

### **PART 2 - PRODUCTS**

#### 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:
  - 1. CECO Door Products (C).
  - 2. Curries Company (CU).
  - 3. Security Metal Products (SMP).

#### 2.02 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

#### 2.03 HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.
- B. Exterior Doors: Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
  - 1. Design: Flush panel.
  - 2. Core Construction: Manufacturer's standard polystyrene. Where indicated, provide doors fabricated as thermal-rated assemblies with a minimum R-value of 2.8 or better.
  - 3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053-inch - 1.3-mm) thick steel, Model 2.
  - 4. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
  - 5. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
  - 6. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Design: Flush panel.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, or one-piece polystyrene core, securely bonded to both faces.
  - a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
3. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
4. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
5. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
6. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Manufacturers Basis of Design:

1. Curries Company (CU) - Polystyrene Core - 707 Series.

#### 2.04 SPECIAL FUNCTION HOLLOW METAL DOORS

A. Bullet Resistant Door Assemblies: Subject to the same compliance standards and requirements as standard hollow metal doors, provide manufacturer's custom bullet resistant internal door construction tested in accordance with U.L. Test Standard 752. Fabricate with concealed armor plate construction, 1-3/4" thickness, in the steel gauge required to meet indicated ballistic rating. Furnish as a complete unit with factory welded frame and approved listed hardware.

1. Provide bullet resistant assemblies with UL752 Level Rating of 1 through 10 as indicated.
2. Manufacturers Basis of Design:
  - a. Curries Company (CU) - 737 Series.

#### 2.05 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.

1. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
2. Manufacturers Basis of Design:

- a. Curries Company (CU) – M CM Series.

C. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
3. Manufacturers Basis of Design:

- a. Curries Company (CU) - C CM Series.
- b. Curries Company (CU) - M Series.
- D. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- E. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

## 2.06 FRAME ANCHORS

### A. Jamb Anchors:

- 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
- 2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
- B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.
- C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

## 2.07 LOUVERS

### A. Metal Louvers: Unless otherwise indicated provide louvers to meet the following requirements.

- 1. Blade Type: Vision proof inverted V or inverted Y.
- 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.
- B. Louvers for Fire Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire protection rating of 1-1/2 hours and less.
  - 1. Manufacturers: Subject to compliance with requirements, provide louvers to meet rating indicated.
  - 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.

## 2.08 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
- C. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.
- D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

## 2.09 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

## 2.010 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.
- C. Hollow Metal Doors:
  - 1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
  - 2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
  - 3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
- D. Hollow Metal Frames:
  - 1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
  - 2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
    - a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
  - 3. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
  - 4. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
  - 5. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
  - 6. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
  - 7. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
  - 8. Jamb Anchors: Provide number and spacing of anchors as follows:

- a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
  - 1) Two anchors per jamb up to 60 inches high.
  - 2) Three anchors per jamb from 60 to 90 inches high.
  - 3) Four anchors per jamb from 90 to 120 inches high.
  - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
- b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
  - 1) Three anchors per jamb up to 60 inches high.
  - 2) Four anchors per jamb from 60 to 90 inches high.
  - 3) Five anchors per jamb from 90 to 96 inches high.
  - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
  - 5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.
9. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
- E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
  1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
  2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
  3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
  4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

## 2.011 STEEL FINISHES

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
  1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

## **PART 3 - EXECUTION**

### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

### 3.03 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
  - 1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
  - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
  - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
  - 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
  - 1. Non-Fire-Rated Standard Steel Doors:
    - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
    - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
    - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
    - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
  - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

### 3.04 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace

- defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
  - C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

**END OF SECTION**

NOT FOR BID

## SECTION 08 11 16

### INTERIOR ALUMINUM DOORS AND FRAMES

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all interior aluminum doors and frames, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.
- B. Section includes:
  - 1. Pre-finished aluminum door frames for interior use.
  - 2. Pre-finished aluminum window frames for interior use.
  - 3. Pre-finished aluminum framing systems for interior use.
  - 4. Pre-finished aluminum and glass doors for interior use.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide aluminum frames, aluminum and glass doors and accessories produced by a single manufacturer for each type of product indicated.
- B. Manufacturer's qualifications: Company specializing in the manufacturing of door frame systems with a minimum of 10 years of documented experience on a comparable sized project.
- C. Fire and smoke rated assemblies:
  - 1. In locations where fire rated openings are scheduled or required by regulatory agencies, provide fire rated aluminum frames that have been tested and certified for specified exposure by an agency acceptable to governing authorities.
  - 2. Provide labels permanently fastened on each fire rated frame that are within size limits established by NFPA and the testing authority.
    - a) Provide 20-minute labels.
    - b) Provide 90-minute labels.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Product data: Manufacturer's fabrication and installation instructions.
  - 1. Include information on factory finish, glazing gaskets, accessories and other required components.
- C. Shop drawings: Submit schedule indicating opening numbers, frame types, dimensions, swings and hardware requirements.



- D. Include elevations and details indicating frame types, profiles, conditions at openings, methods and locations of anchoring, glazing requirements, hardware locations and reinforcements for hardware.
- E. Samples: Submit the following:
  - 1. Full range of manufacturer's standard finishes for the Architect's selection.
  - 2. Where normal color variations are expected, include additional samples to show range of such variation.
- F. Instructions: Provide copies of manufacturer's data for fabrication and installation of aluminum door frames.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver frames and doors cartoned to provide protection during transit and storage at project site.
- B. Inspect frames and doors upon delivery for damage.
  - 1. Repair minor damage to pre-finished products by means as recommended by the manufacturer.
  - 2. Replace frames that cannot be satisfactorily repaired.
- C. Store frames at the project site under cover and as near as possible to the final installation location. Do not use covering material that will cause discoloration of aluminum finish.

#### 1.08 PROJECT CONDITIONS

- A. Do not begin installation of the frames or doors until the area of work has been completely enclosed and the interior is protected from the elements.
- B. Maintain temperature and humidity in areas of installation within reasonable limits, as close as possible to final occupancy. If necessary, provide temperature control and ventilation to maintain required environmental conditions.

#### 1.09 WARRANTY

- A. Warrant against defects in manufacturing of materials for a period of 2 years from date of substantial completion.
- B. Warrant framing finish against defects, including cracking, flaking, blistering, peeling and excessive fading, chalking and non-uniformity in color for a period of 5 years.

### **PART 2 - PRODUCTS**

#### 2.01 MANUFACTURERS

- A. Basis of Design Manufacturer: **Wilson Partitions**; Address: 2301 E. Vernon Ave., Vernon, CA 90058. Toll Free: (866) 443-7258, (323) 908-5451 Fax, [www.wilsonpart.com](http://www.wilsonpart.com)
- B. Or Architect approved equal.

#### 2.02 MATERIALS

- A. Aluminum: Controlled alloy billets meeting requirements of ASTM B221, 6063 T5 alloy, to assure compliance with tight dimensional tolerances and maintain color uniformity.
- B. Recycled content of Aluminum Products: Minimum weighted average scrap content of the extrusions to be 47.9%. This includes a post-consumer scrap content of 11/1% and a pre consumer scrap content of 36.8%. The remaining 52.1% of the extrusions to be prime aluminium.

## 2.03 INTERIOR ALUMINUM FRAMES

A. **Snap-On Trim Profile:** Provide frames with the following characteristics:

1. Rectilinear design.
2. Trim: 2"
3. Series 525: 5-1/4" throat.
4. Series 725: 7-1/4" throat.
5. Accepts 1/4", 3/8" and 1/2" glass.

## 2.04 INTERIOR ALUMINUM DOORS

A. Provide 1-3/4" doors with the following characteristics:

1. Tubular design.
2. Narrow stile (2")
3. Medium stile (3-1/2")
4. Wide stile (5-1/16")
5. Top rail (3-1/4")
6. Top rail (5-1/8")
7. Bottom rail (9-1/2")
8. 1/2" glass stops for 1/4" glass
9. 3/4" glass stops for 3/8" glass

## 2.05 FABRICATION

- A. Pre-machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required, and fastened within the frame.
- B. Provide corner reinforcements and alignment clips for precise butt or mitered connections.
- C. Fabricate all components to allow secure installation without exposed fasteners.
- D. Manufacturer shall pre-cut and ship all frame materials knock-down.

## 2.06 FINISHES

- A. Factory finish extruded frame components so that any part exposed to view upon completion of installation will be uniform in finish and color.
- B. Clear Anodic Coating (AC-2): Comply with AAMA 611. Commercial, AAM12C22A21 anodized coating, less than .04 mil minimum thick.

# PART 3 – EXECUTION

## 3.01 EXAMINATION

- A. Examine project conditions and verify that the work of this section may properly commence. Do not proceed with the installation until unsatisfactory conditions have been corrected.
- B. Verify that the wall thickness does not exceed manufacturer's recommended tolerances of specified frame throat size.

## 3.02 INSTALLATION

- A. Comply with frame manufacturer's printed installation instructions and approved shop drawings. Strictly adhere to maintaining specified wall thickness to ensure dimension does

not exceed frame throat size specified. Installation not to be attempted in areas where the wall thickness exceeds the tolerance of the specified throat size.

- B. Install frames plumb and square, securely anchored to substrates with fasteners recommended by frame manufacturer.
  - 1. Use concealed installation clips to assure that splices and connections are tightly butted and properly aligned.
  - 2. Secure clips to main structural extrusion components and not to snap-in or trim members.
  - 3. Do not use screws or other fasteners that will be exposed to view when installation is complete.

3.03 ADJUSTING AND CLEANING

- A. Clean exposed frames promptly after installation, using cleaning methods recommended by frame manufacturer.
- B. Touch up marred areas so that touch-up is not visible from a distance of 4 feet. Remove and replace frames that cannot be satisfactorily adjusted.

3.04 PROTECTION

- A. Provide protection required to assure that frames will be without damage or deterioration upon substantial completion of the project.

## SECTION 08 14 23.16

### PLASTIC-LAMINATE-FACED WOOD DOORS

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

###### A. Section Includes:

1. Interior flush wood doors.

###### B. Related Requirements:

1. Section 08 71 00: Door hardware.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

###### B. Pre-installation Meeting

1. Conduct pre-installation meeting at Project Site.
2. Discuss Topics:
  - a. Delivery, storage and handling
  - b. Coordination and Hardware and access control installers.
  - c. Protection of installed doors.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 23 Submittal Procedures.

B. Product Data: Each type of door and finish.

1. Core and edge construction.
2. Fire rated doors.
3. Finishes.

C. Shop Drawings and Schedule:

1. Use same unit designations used in Contract Documents.
2. Hardware and wiring chase preparation.

D. Samples for Verification:

1. Each required plastic laminate; corner unit showing construction and finish minimum 8 by 10 inches.

##### 1.07 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 01 60 00 Materials and Equipment.

- B. Package factory-finished doors individually in manufacturer's standard plastic bags, stretch wrap, or cardboard cartons.
- C. Store doors inside building in clean, dry location.
- D. Mark each door on top bottom rail with opening number used on Shop Drawings.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity at occupancy levels during remainder of construction period.

1.09 OPERATION AND MAINTENANCE DATA

- A. Provide in accordance with Section 01 77 00 Project Closeout.
- B. Provide manufacturer data.
- C. Provide Manufacturer warranties transferrable to Owner.

1.010 WARRANTIES

- A. Provide manufacturer's standard warranty in accordance with Section 01 78 36 Warranties and Bonds.
- B. Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Warping (bow, cup, or twist) more than 1/4 inch (6 mm) in 42-by-84-inch (1065-by-2130-mm) section.
    - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in 3-inch (0.25 mm in 76-mm) span.
  - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
- C. Warranty Periods:
  - 1. Solid-Core Interior Doors and Wood Frames: Life of installation.

**PART 2 - PRODUCTS**

2.01 MANUFACTURERS

- A. Basis of Design: Products of Aspiro™ Series | Marshfield-Algoma by Masonite Architectural are specified to indicate requirements for quality and appearance.
  - 1. Website: [masonite.com/architectural/products/Aspiro-series](http://masonite.com/architectural/products/Aspiro-series)
  - 2. Phone: 877.332.4484
- B. Approved alternates
  - 1. Oregon Door
  - 2. Lynden Door – LD Series Only
  - 3. Architect approved equal.
- C. Source Control: Supply all wood doors from a single manufacturer.

2.02 MANUFACTURING STANDARDS

- A. Interior Flush Wood Doors: Window & Door Manufacturers Association publication ANSI/WDMA I.S. 1A "Industry Standard for Interior Architectural Wood Flush Doors".

- B. Fire-Rated Wood Doors: Conforming to NFPA 80; listed and labeled for required ratings based on testing at positive pressure NFPA 252 or UL 10C by UL or other testing agency acceptable to authorities having jurisdiction
1. Temperature-Rise Limit: Where indicated, provide doors that have a maximum transmitted temperature end point of not more than 250 deg F (121 deg C) above ambient after 30 minutes of standard fire-test exposure.
  2. Blocking: Provide composite blocking approved for use in doors of fire-protection ratings indicated as needed to maintain WDMA performance level and eliminate through-bolting hardware.
  3. Vertical Edge Construction:
    - a. Category A Positive Pressure: Integral intumescent seals concealed by outer stile where required.
  4. Pairs: Fire-retardant stiles with concealed intumescent seals that are listed and labeled for applications indicated without formed-steel edges and astragals.
- C. Smoke and Draft Control Door Assemblies: Listed and labeled for smoke and draft control

2.03 SOLID CORE LAMINATE-FACED (HPDL) DOORS – CHOICE LAMINATE

- A. Basis of Design: Aspiro™ Series | Marshfield-Algoma™ by Masonite Architectural.
- B. Solid Core Choice Laminate (HPDL) Flush Doors:
1. WDMA Quality grade: Custom
  2. WDMA Performance Level: Extra Heavy Duty
  3. Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS. Vertical and post formable grade laminates are not acceptable.
    - a. Colors, Patterns: As indicated in the Drawings
    - b. Acceptable manufacturer: Wilsonart Standard Laminate
  4. Vertical Edges: Matching HPDL Edge Band applied after faces over Structural Composite Lumber. Matching 1/8 inch (3.2mm) high impact edge bonded to structural composite lumber.
  5. Horizontal Edges: Structural composite lumber.
  6. Core: Wood-based Particleboard (PC).
  7. Construction: Five Plies; stiles and rails bonded to core, and entire unit is abrasive planed. High pressure decorative laminate with high density fiberboard (HDF) crossbands.
  8. Thickness: 1-3/8 inch
- C. Solid Core Choice Laminate (HPDL) Flush Doors with Glazed Lites:
1. Match appearance grade and applicable construction and performance requirements of other laminate finish flush wood doors.
  2. Factory Glazing: Refer to Section 08 80 00 "Glazing" for glass view panels in flush wood doors. Factory install glass as required. Fill glazing bead nail holes in factory finished doors.
  3. Glazing: Factory-installed fire-rated safety glass for door rating.
  4. Metal Glazing Frames: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish.
    - a. Frame Design: Metal Vision Frame 110
- D. Fire-Rated Choice Laminate (HPDL) Flush Doors:

1. Match appearance grade and applicable construction and performance requirements of other laminate finish flush wood doors.
2. Ratings: Category A positive pressure
  - a. 20-Minute Doors: Wood-based particleboard core
  - b. 45-, 60-, 90-Minute Doors: Mineral core with blocking options.
3. Vertical Edges: High pressure decorative laminate over hardwood composite fire stile.

#### 2.04 FABRICATION

- A. Factory Fitting: Fit to frame openings with clearances specified in WDMA I.S. 1A.
  1. Undercut: Maximum 3/8 inch (10 mm) above thresholds.
  2. Fire-Rated Doors: Comply with NFPA 80.
- B. Factory Machining: Machine doors for hardware that is not surface applied.
  1. Verify dimensions for hardware mortises in metal frames before machining.
- C. Contractor Option: Doors supplied with wood frames may have hardware installed at factory.
- D. Door Frames:
  1. Supply frames with temporary spreader bars at base.

#### 2.05 FINISHES

- A. Finish Grade: Match grade of door.

### **PART 3 - EXECUTION**

#### 3.01 EXAMINATION

- A. Verify that door frames are plumb, square, and accurate size.
- B. Inspect each door before installation for damage and defects per WDMA Section F-6.

#### 3.02 INSTALLATION

- A. Hardware installation is conforming to Section 08 7100 – Door Hardware.
- B. Reference Standards:
  1. Wood Doors: WDMA I.S. 1A
  2. Fire-Rated Doors: NFPA 80.
  3. Smoke-and Draft-Control Doors: NFPA 105.
- C. Align doors with uniform vertical and top edge clearance.

#### 3.03 REPAIR

- A. Repair of damage or defects is subject to Architect's acceptance, including removal of soiling. Provide new replacement doors for doors that cannot be satisfactorily repaired.

#### 3.04 PROTECTING AND CLEANING

- A. Protect installed doors from damage and soiling.
- B. Clean doors shortly before inspection for Substantial Completion.

**END OF SECTION**

## SECTION 08 31 13

### ACCESS DOORS AND FRAMES

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Non-Rated Architectural wall and ceiling access door.
- B. Related hardware and attachments.
- C. Design Requirements: Verification: Obtain specific locations and sizes for required access doors and frames from trades, including mechanical and electrical, requiring access to concealed equipment and indicate on submittal schedule.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain access door and panel units, and frames for entire Project from 1 source and 1 single manufacturer.
- B. Size Variations: Obtain Architect's acceptance and approval of manufacturer's standard size units that may vary slightly from sizes indicated on Drawings.
- C. Coordination: Provide inserts and anchoring devices that will be built into other Work for installation of access door assemblies. Coordinate delivery with other Work to avoid delay.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Shop Drawings:
  - 1. Door and panel units: Show types, elevations, thickness of metals, full size profiles of door members.
  - 2. Hardware: Show materials, finishes, locations of fasteners, types of fasteners, locations and types of operating hardware, and details of installation.
  - 3. General: Show connections of units and hardware to other Work. Include schedules showing location of each type and size of door and panel units.
- C. Product Data: Manufacturer's technical data for each type of access door and panel assembly, including setting drawings, templates, fire-resistive characteristics, finish requirements, and details of anchorage devices. Include complete schedule, types, locations, construction details, finishes, latching or locking provisions, and other pertinent data.
- D. Manufacturer's Installation Instructions: Indicate installation requirements and rough-in dimensions.

##### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01 66 00 Product Storage and Handling Requirements.
- B. Package and ship per manufacturer's recommendations.
- C. Store per manufacturer's instructions.



D. Store in dry area out of direct sunlight.

1.08 PROJECT CONDITIONS

Comply with the requirements of Section 01 50 00.

1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

1.10 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 - PRODUCTS**

2.01 MANUFACTURERS

A. Basis of Design: Nystrom Building Products: 9300 73rd Avenue North Brooklyn Park, MN 55428. Telephone: 800-547-2635. E-Mail: info@nystrom.com. Website: www.nystrom.com

B. Specifications and Drawings are based on manufacturer's literature from Nystrom Building Products. Other manufacturers shall comply with minimum levels of material, color selection, and detailing indicated in Specifications or on Drawings.

2.02 MATERIALS

A. Commercial quality, cold steel sheet with white baked on powder coat finish.

B. Galvanized, bonderized steel with white baked on powder coat finish.

2.03 ACCESS PANELS

A. Flush Access Doors (Model: NW) with Concealed Flanges for drywall (Non-Rated, General Purpose Access Door)

1. Door: Fabricate from 16-gauge cold rolled sheet steel, with multiple mounting configurations.

2. Door Size: 14"x14" and 24"x24" (see Plans for locations)

3. Frame: Fabricate from 16-gauge cold rolled sheet steel. Provide 1/4 inch mounting holes and easy install tabs.

a. Wallboard surfaces – Integrated 16-gauge drywall bead and frame.

4. Hinge:

a. Concealed spring button type, to allow for door removal.

5. Latching/Locking Devices: Cam latch, hex-head wrench operated

6. Finish:

a. Type: No. 304 stainless steel with No. 4 satin polish finish.

B. Fire-Rated, Flush Access Doors (Model: IW) with Concealed Flanges.

1. Door: Face flush with frame with a core of mineral-fiber insulation enclosed in sheet metal, concealed flange for gypsum board installation, self-closing door. Fabricate from 20-gauge sheet metal, with multiple mounting configurations.

2. Door Size: 14"x14" and 24"x24" (see Plans for locations)

3. Frame: Fabricate from 16-gauge cold rolled sheet steel. Provide 1/4 inch mounting holes and easy install tabs.

a. Wallboard surfaces – Integrated 16-gauge drywall bead and frame.

4. Hinge:

- b. Concealed hinge.
- 5. Latching/Locking Devices: Self-closing, self-latching door hardware operated by key.
- 6. Finish:
  - b. Type: No. 304 stainless steel with No. 4 satin polish finish.
- 7. Fire-Resistance Rating: 1-1/2 hours for walls, 3 hours for ceilings.
- 8. Temperature-Rise Rating: 250 deg F at the end of 30 minutes
- 9. Performance Requirement: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency for fire-protection and temperature-rise limit ratings indicated, accordingly to NFPA 252 or UL 10B.

#### 2.04 FABRICATION

- A. Manufacture each access panel assembly as an integral unit ready for installation.
- B. Framing to include integral anti-flexing technology, with ¼ inch mounting holes, to reduce the twist of frame during installation.
- C. Easy Install Tabs integral to framing for multiple installation methods.
- D. Furnish number of latches required to hold door in flush, smooth plane when closed.

### **PART 3 - EXECUTION**

#### 3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that rough openings for door and frame are correctly sized and located.
- C. Verify mechanical and electrical requirements for ceiling or wall access panels.
- D. Correct conditions detrimental to timely and proper completion of the Work.
- E. Do not proceed until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of conditions.

#### 3.02 PREPARATION

Advise installers of work relating to access panel installation including rough opening dimensions, locations of supports, and anchoring methods. Coordinate delivery with other work to avoid delay.

#### 3.03 INSTALLATION

- A. Install access door and frame units per manufacturer's written instructions.
- B. Install frames plumb and level in opening. Secure rigidly in place.
- C. Position units to provide convenient access to concealed Work requiring access.

#### 3.04 ADJUST AND CLEAN

- A. Adjust panel after installation for proper operation.
- B. Remove and replace panels or frames that are warped, bowed, or damaged.

**END OF SECTION**

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## SECTION 08 33 44

### OVERHEAD COILING SMOKE & FIRE CURTAIN

#### PART 1 - GENERAL

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

###### A. Section Includes:

1. Fire-protective curtain assemblies for window openings.
2. Fire- and smoke-protective curtain assemblies.
3. Fire- and smoke-protective curtain assemblies with egress.
4. Fire-protective curtain assemblies for horizontal openings.
5. Fire-protective curtain assemblies for perimeter applications.

##### 1.03 PREINSTALLATION MEETINGS

###### A. Preinstallation Conference: Conduct conference at Project site.

##### 1.04 COORDINATION

- A. Coordinate fire- and smoke-protective curtain assemblies with power, signal, fire-alarm, and smoke-detection systems specified in Division 26 and Division 28.
- B. Coordinate fire- and smoke-protective curtain assemblies with ceilings for operational clearances and maintenance access requirements.
- C. Coordinate fire- and smoke-protective curtain assemblies with walls for support requirements, rating continuity above ceilings, and recessed wall switches.
- D. Coordinate requirements for metal supports required for fire- and smoke-protective curtain assemblies.

##### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: An entity experienced in manufacturing smoke-and-draft-control curtain assemblies that have been successfully installed in compliance with requirements of authorities having jurisdiction.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
- C. Fire-Protective Curtain Assembly Inspector Qualifications: Inspector for field quality-control inspections of fire- and smoke-protective curtain assemblies complying with NFPA 80.

##### 1.06 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.07 SUBMITTALS

###### A. Product Data: For each type of fire- and smoke-protective curtain assembly and fire door.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protective curtain assemblies.

2. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
3. Include ratings, operating components, electrical characteristics, control systems, and furnished specialties and accessories.

**B. Shop Drawings:**

1. Include plans, elevations, sections, and attachment details.
2. Include details of fire-protective curtain assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location of each field connection.
3. Detail fabrication and assembly of fire-protective curtain assemblies.
4. Show locations of controls, detectors or replaceable fusible links, and other accessories.
5. Include diagrams for power, signal, and control wiring.

**C. Product Schedule:** For fire-protective curtain assemblies.

**D. Qualification Data:** For Installer, manufacturer, testing agency, and factory-authorized service representative.

**E. Evaluation Reports:** For curtain assemblies, from a qualified testing agency.

**F. Field quality-control reports.**

**G. Sample Warranty:** For manufacturer's special warranty.

**1.08 OPERATION AND MAINTENANCE DATA**

**A. Operation and Maintenance Data:** For fire-protective curtain assemblies to include in emergency, operation, and maintenance manuals.

**B. Field quality-control reports for required testing.**

**1.09 FIELD CONDITIONS**

**A. Field Measurements:** Field-verify and coordinate dimensions and indicate measurements on Shop Drawings.

**1.010 WARRANTY**

Provide manufacturer's standard warranty in accordance with Section 01 78 36 Warranties.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS, GENERAL**

**A. Source Limitations:** Obtain fire-protective curtains from single source from single manufacturer.

1. Obtain operators and controls from fire-protective curtain manufacturer.

**2.02 PERFORMANCE REQUIREMENTS**

**A. Fire-Protective Curtain Assemblies:** Complying with NFPA 80; listed and labeled by qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible in accordance with UL 10D.

1. Oversize Rated Curtain Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that curtain assemblies comply with

standard construction requirements for tested and labeled fire-rated curtain assemblies, except for size.

2. Smoke Control: Provide smoke- and fire-protective curtain assemblies that are listed and labeled with the letter "S" on the rating label by a qualified testing agency for smoke- and draft-control based on testing in accordance with UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m) of opening at 0.10 inch wg (24.9 Pa) for both ambient and elevated temperature tests.
- B. Curtain Fabric Fire-Test-Response Characteristics: Provide products that pass NFPA 701, as determined by testing of fabrics that were treated using treatment-application method intended for use for this Project by a testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Seismic Performance: Smoke-protective curtain assembly shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
  1. Component Importance Factor: [1.5] [1.0].

## 2.03 FIRE-PROTECTIVE CURTAIN ASSEMBLIES FOR WINDOW OPENINGS

- A. Passively activated fire-protective curtain assemblies restrained by curtain guides at each jamb of an opening.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Smoke Guard; a CSW Industrials Company; M1000 or comparable product by one of the following:
    - a. McKeon Rolling Steel Door Co., Inc.
    - b. Stöbich Fire Protection.
    - c. Or Architect approved equal.
- B. Fire-Resistance Rating: Comply with the following; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. NFPA 252 Rating: 20minutes.
  2. UL 10B Rating: 20 minutes.
  3. UL 10D Rating: 120 minutes.
- C. Curtain: Manufacturer's standard multilayer glass-fiber fabric reinforced with stainless steel wires and coated on one or both sides.
- D. Maximum Opening Size (Width by Height): 8 by 10 ft. (1.52 by 3.05 m).
- E. Control System: Provide factory-assembled control unit as required for assembly specified.
  1. Fail-safe, gravity-closing device deploys on activation of fusible link or testing key switch.
  2. Replaceable fusible link with temperature rise and melting point of 165 deg F (74 deg C)
- F. Housing Type: Sheet metal housings containing support rollers.
- G. Side Guides: Formed from galvanized-steel sheet complying with ASTM A653/A653M.

2.04 FIRE- AND SMOKE- PROTECTIVE CURTAIN ASSEMBLIES FOR FIXED OPENINGS AND CORRIDORS

- A. Alarm-activated fire- and smoke-protective curtain assemblies restrained by curtain guides at each jamb of an opening.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Smoke Guard; a CSW Industrials Company; M2100 Fire and Smoke or comparable product by one of the following:
    - a. McKeon Rolling Steel Door Company, Inc.
    - b. Stöbich Fire Protection.
    - c. Or Architect approved equal.
- B. Fire-Resistance Ratings: Comply with the following; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. NFPA 252 Rating: 20 minutes.
  - 2. UL 10B Rating: 20 minutes.
  - 3. UL 10C Rating: 20 minutes (without hose stream test).
  - 4. UL 10D Rating: 2 hours.
- C. Smoke Containment: Assemblies complying with UL 1784 for air leakage.
- D. Curtain: Manufacturer's standard multilayer glass-fiber fabric reinforced with stainless steel wires and coated on one or both sides complying with ASTM E84.
- E. Maximum Opening Size (Width by Height): 16 by 12 ft. (4.88 by 3.66 m), 30 by 25 ft. (9.14 by 7.62 m), 40 by 20 ft. (12.19 by 6.10 m), 50 by 16 ft. (15.24 by 4.88 m), and 60 by 12 ft. (18.29 by 3.66 m).
- F. Operation: Controlled descent automatically by fail-safe gravity deployment and motorized rewind.
- G. Roller: Cold-formed steel tube complying with ASTM A500/A500M.
- H. Side Guides: Formed from galvanized-steel sheet complying with ASTM A653/A653M, with integral pressure-retaining tabs.
- I. Control System: Provide factory-assembled control unit as required for assembly specified.
  - 1. Fail-safe, gravity-closing device deploys on activation of local smoke detector or testing key switch in compliance with UL 864.
  - 2. Fail-safe, gravity-closing device deploys on activation local smoke detector and building fire alarm or testing key switch in compliance with UL 864.
  - 3. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended in writing by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.
  - 4. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 5. Battery Backup: Manufacturer's standard battery backup sized for motor power requirements.
- J. Housing Type: Sheet metal housings with support rollers and associated electronics.

1. Include wiring from control stations to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

## 2.05 FIRE- AND SMOKE-PROTECTIVE CURTAIN ASSEMBLIES WITH EGRESS

- A. Alarm-activated fire- and smoke-protective curtain assemblies restrained by curtain guides at each jamb opening with egress.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Smoke Guard; a CSW Industrials Company; M2500 Egress or comparable product by one of the following:
    - a. McKeon Rolling Steel Door Co., Inc.
    - b. Stöbich Fire Protection.
    - c. Or Architect approved equal.
- B. Fire-Resistance Ratings: Comply with UL 10D; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. NFPA 252 Rating: 20 minutes.
  2. UL 10B Rating: 20 minutes.
  3. UL 10C Rating: 20 minutes (without hose stream test).
  4. UL 10D Rating: 2 hours.
- C. Smoke Containment: Assemblies complying with UL 1784 for air leakage.
- D. Curtain: Manufacturer's standard multilayer glass-fiber fabric reinforced with stainless steel wires and coated on one or both sides with flame-spread and smoke-developed indexes of 25 and 450, respectively, when tested in accordance with ASTM E84.
  1. Integrated Fabric Egress Opening: Manufacturer's standard swinging fabric flap with overlapping design to maintain fire and smoke rating.
    - a. Readily operable egress flap from egress size without use of keys, tools, special knowledge, or manual effort in compliance with opening force requirements of authorities having jurisdiction.
- E. Maximum Opening Size (Width by Height): 15 by 20 ft. (4.57 by 6.10 m), 40 by 12 ft. (12.19 by 3.66 m), 50 by 16 ft. (15.24 by 4.88 m), and 60 by 12 ft. (18.29 by 3.66 m).
- F. Operation: Controlled descent automatically by fail-safe gravity deployment and motorized rewind.
- G. Roller: Cold-formed steel tube complying with ASTM A500/A500M.
- H. Side Guides: Formed from galvanized-steel sheet complying with ASTM A653/A653M, with integral pressure-retaining tabs.
- I. Control System: Provide factory-assembled control unit as required for assembly specified.
  1. Fail-safe, gravity-closing device deploys on activation of local smoke detector or testing key switch in compliance with UL 864.
  2. Fail-safe, gravity-closing device deploys on activation local smoke detector and building fire alarm or testing key switch in compliance with UL 864.
  3. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended in writing by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.



4. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.
  5. Battery Backup: Manufacturer's standard battery backup sized for motor power requirements.
- J. Housing Type: Sheet metal housings with support rollers and associated electronics.
1. Include wiring from control stations to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
- 2.06 FIRE-PROTECTIVE CURTAIN ASSEMBLIES FOR HORIZONTAL OPENINGS
- A. Alarm-activated fire-protective curtain assemblies restrained by curtain guides at each side of a horizontal opening.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Smoke Guard; a CSW Industrials Company; M3000 or comparable product by one of the following:
    - a. McKeon Rolling Steel Door Company, Inc.
    - b. Stöbich Fire Protection.
    - c. Or Architect approved equal.
- B. Fire-Resistance Ratings: Comply with the following; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. NFPA 252 Rating: 20 minutes.
  2. UL 10B Rating: 20 minutes.
  3. UL 10C Rating: 20 minutes (without hose stream test).
  4. UL 10D Rating: 2 hours.
- C. Curtain: Manufacturer's standard multilayer glass-fiber fabric reinforced with stainless steel wires and coated on one side.
- D. Maximum Opening Size (Width by Height): 20 by 30 ft. (6.10 by 9.14 m).
- E. Operation: Motor-driven automatic operation.
- F. Roller: Cold-formed steel tube complying with ASTM A500/A500M.
- G. Side Guides: Manufacturer's standard side guides formed from galvanized-steel sheet complying with ASTM A653/A653M.
- H. Control System: Provide factory-assembled control unit as required for assembly specified.
1. Motor-driven device deploys on activation of local smoke detector or testing key switch in compliance with UL 864.
  2. Motor-driven device deploys on activation of local smoke detector and building fire alarm or testing key switch in compliance with UL 864.
  3. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended in writing by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.
  4. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Battery Backup: Manufacturer's standard battery backup sized for motor power requirements.
  - I. Housing Type: Sheet metal housings with support rollers and associated electronics.
    1. Include wiring from control stations to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
- 2.07 FIRE-PROTECTIVE CURTAIN ASSEMBLIES FOR PERIMETER APPLICATIONS
- A. Alarm-activated fire-protective curtain assemblies forming open or closed rectangular or polygonal configurations with or without side-guide captures.
    1. Basis-of-Design Product: Subject to compliance with requirements, provide Smoke Guard; a CSW Industrials Company; M4000 or comparable product by one of the following:
      - a. McKeon Rolling Steel Door Co., Inc.
      - b. Stöbich Fire Protection.
      - c. Or Architect approved equal.
  - B. Fire-Resistance Rating: Comply with UL 10D; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    1. Rating: 120 minutes.
  - C. Curtain: Manufacturer's standard multilayer glass-fiber fabric reinforced with stainless steel wires and coated on one side.
    1. Corner Curtain: Fabricated accordion-fold corner curtain assembly to maintain fire and smoke rating at intersection of curtains not in same plane.
  - D. Maximum Opening Size (Width by Length): 15 by 20 ft. (4.57 by 6.10 m).
  - E. Operation: Motor-driven automatic operation.
  - F. Roller: Cold-formed steel tube complying with ASTM A500/A500M.
  - G. Side Guides: Manufacturer's standard side guides formed from galvanized-steel sheet complying with ASTM A653/A653M.
  - H. Control System: Provide factory-assembled control unit as required for assembly specified.
    1. Motor-driven device deploys on activation of local smoke detector or testing key switch in compliance with UL 864.
    2. Motor-driven device deploys on activation of local smoke detector and building fire alarm or testing key switch in compliance with UL 864.
    3. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended in writing by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.
    4. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.
    5. Battery Backup: Manufacturer's standard battery backup sized for motor power requirements.
  - I. Housing Type: Sheet metal housings with support rollers and associated electronics.
    1. Include wiring from control stations to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install fire-protective curtain assemblies in accordance with manufacturer's written installation instructions and in compliance with NFPA 80.
- B. Power-Operated Curtains: Install in accordance with UL 325.
- C. Install anchorage devices to securely fasten assembly to substrate and building framing without distortion or stress.
- D. Securely brace components suspended from structure.
- E. Fit and align assembly, including vertical guides, level and plumb, to provide smooth operation.
- F. Adjust fire-protective curtain assemblies to function smoothly, as recommended by manufacturer.

### **3.03 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified opening protective assembly inspector to perform tests and inspections and to furnish reports to Architect.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Test release mechanism, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed curtain. Reset closing mechanism after successful test.
  - 2. Inspections: Inspect each fire-protective curtain in accordance with NFPA 80.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-protective curtain assembly indicating compliance with each item listed in NFPA 80.

### **3.04 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling fire curtains.

### **3.05 MAINTENANCE**

- A. Engage a manufacturer's authorized service representative to test, adjust, and maintain the fire-protective assemblies once per year as required by NFPA 80.

**END OF SECTION**

## SECTION 08 34 53.10

### BULLET RESISTANT DOORS AND FRAMES

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all bullet-resistant doors and frames, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the industry standards and references as established by the manufacturer.

##### 1.04 QUALITY ASSURANCE

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Templates: Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Include the following:
  - 1. Elevations of each door design.
  - 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
  - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 4. Locations of reinforcement and preparations for hardware.
  - 5. Details of each different wall opening condition.
  - 6. Details of anchorages, joints, field splices, and connections.
  - 7. Details of accessories.
  - 8. Details of moldings, removable stops, and glazing.
  - 9. Details of preparations for power, signal, and control systems.
- D. Samples for Verification:
  - 1. Samples are only required by request of the architect and for manufactures that are not current members of the Steel Door Institute.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver bullet resistant hollow metal work palletized and crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store bullet resistant hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.
  - 1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.08 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.09 COORDINATION

- A. Coordinate installation of anchorages for bullet resistant hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.010 WARRANTY

- A. Provide manufacturer's written 5-year warranty against defects in materials and workmanship upon final completion and acceptance of Work in this section.

**PART 2 - PRODUCTS**

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CECO Door Products (C).
  - 2. Curries Company (CU).
  - 3. Security Metal Products (SMP).

2.02 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.03 BULLET RESISTANT HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of type and design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
  - 1. Design: Flush panel.
  - 2. Core Construction: Manufacturer's standard bullet resistant door core construction designed and tested for the specified UL752 standard Level rating.

a. Fire Door Core: As required to provide fire-protection level specified.

3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 14 gage (0.067-inch -1.7-mm) thick steel, Model 2 (Fully welded, seamless face and edges).
4. Vertical Edges: Vertical edges to have the face sheets joined by a continuous weld extending the full height of the door. Welds are to be ground, filled and dressed smooth. Beveled Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 12 gage (0.105-inch -2.7 mm), extending the full width of the door and welded to the face sheet. Finish top and bottom to provide a smooth flush condition.
6. Surface Applied Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

#### 2.04 BULLET RESISTANT HOLLOW METAL FRAMES

- A. General: Provide frames of the type and profile indicated, not less than thickness indicated; to comply with ANSI/SDI A250.8.
  1. Fabricate frames with mitered corners.
  2. Fabricate frames with "closed and tight" mitered, full depth continuously welded seams, finished smooth with no visible seam unless otherwise indicated. Knock down type frames are not permitted.
  3. Minimum 14 gage (0.067-inch -1.7-mm) thick steel sheet.
- B. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- C. Surface Applied Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

#### 2.05 FRAME ANCHORS

- A. Jamb Anchors:
  1. Masonry Type: Adjustable strap-and-stirrup anchors to suit frame size, not less than 16 gage (0.8 mm) thickness, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long.
- B. Floor Anchors: Floor anchors to be provided at each jamb. Formed from same material as frames, not less than 14 gage (0.067-inch -1.7-mm) thick.
- C. Mortar Guards: Provide minimum 26 gage mortar guards welded to the back of each hardware cutout.

#### 2.06 FABRICATION

- A. Fabricate bullet resistant hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- B. Tolerances: Fabricate bullet resistant hollow metal work to tolerances indicated in ANSI/SDI A250.8.
- C. Bullet Resistant Hollow Metal Doors:
  1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape.

2. Astragals: Provide overlapping astragals on one leaf of pairs of doors where required for bullet resistance level standard or by NFPA 80 for fire-performance rating. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.
  3. Continuous Hinge Reinforcement: Provide welded continuous 12 gage strap for continuous hinges specified in hardware sets in Division 08 Section, "Door Hardware".
- D. Bullet Resistant Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
1. Welded Frames: Full depth continuously weld frame seams; grind, fill, dress, and make smooth and flush.
    - a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
  2. High Frequency Hinge Reinforcement: Provide 12 gage angle reinforcements for butt type hinges on every door and frame assembly.
  3. Continuous Hinge Reinforcement: Provide welded continuous 12 gage straps for continuous hinges specified in hardware sets in Division 08 Section, "Door Hardware".
  4. Electrical Knock Out Boxes: Factory weld 18 gage electrical knock out boxes to frame for electrical hardware preps; this includes but not limited to electric through wire transfer hardware, electrical raceways and wiring harnesses, door position switches, electric strikes, magnetic locks, and jamb mounted card readers as noted in door hardware sets in Division 08 Section, "Door Hardware".
    - a. Provide electrical knock out boxes as required for Project.
    - b. Conduit to be coordinated and installed in the field (Division 26) from middle hinge box and strike box to door position box.
    - c. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 08 Section, "Door Hardware".
    - d. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb.
  5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
  6. Jamb Anchors: Provide number and spacing of anchors as follows:
    - a. Masonry Types: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
      - 1) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 84 inches (2137 mm) high.
- E. Surface Hardware Preparation: Factory prepare bullet resistant hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section, "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.

2. Reinforce doors and frames to receive non-template, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of bullet resistant hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

## 2.07 STEEL FINISHES

- A. Prime Finish: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
  1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

## **PART 3 - EXECUTION**

### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. General Contractor to verify the accuracy of dimensions given to door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded bullet resistant hollow metal frames for squareness, alignment, twist, and plumbness.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

### 3.03 INSTALLATION

- A. General: Install bullet resistant hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Bullet Resistant Hollow Metal Frames: Install bullet resistant hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
  1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
    - a. At fire-protection-rated openings, install frames according to NFPA 80.



- b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
        - c. Install door silencers in frames before grouting.
      - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
      - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with appropriate mortar.
      - 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame.
    - C. Bullet Resistant Hollow Metal Doors: Fit bullet resistant hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
      - 1. Non-Fire-Rated Standard Steel Doors:
        - a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
        - b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
        - c. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).
      - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- 3.04 ADJUSTING AND CLEANING
- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including bullet resistant hollow metal work that is warped, bowed, or otherwise unacceptable.
  - B. Remove grout and other bonding material from bullet resistant hollow metal work immediately after installation.
  - C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

**END OF SECTION**

## SECTION 08 41 13

### ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

#### PART 1 – GENERAL

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

A. Section includes: Aluminum-Framed Storefront

1. Arcadia, Inc., AFG451T Series, 2" x 4-1/2" Thermally broken; offset glazed system, screw spline, shear block, compensating stick or punched opening fabrication for 1" glass.

##### 1.03 STANDARDS AND REFERENCES

- A. American Architectural Manufacturers Association (AAMA)
- B. American Society for Testing and Materials (ASTM)
- C. Aluminum Association (AA)

##### 1.04 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Obtain entrances, storefronts, ribbon walls, window walls, curtain walls, window systems, and finish through one source from a single manufacturer.

B. Provide test reports from AAMA accredited laboratories certifying the performances as specified in 1.03.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

Provide in accordance with Section 01 33 00 Submittal Procedures.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 SYSTEM DESCRIPTION

A. General: In addition to requirements shown or specified, comply with:

1. Applicable provisions of AAMA Aluminum Storefront and Entrance Manual for design, materials, fabrication and installation of component parts.

B. Design Requirements: Arcadia AFG451T Series is a framing system that provides for flush glazing on all sides without projected stops, with glass forward or inward of the frame. Framing system suitable for outside or inside glazing.

C. Performance Requirements:

1. Limit air leakage through assembly to 0.06 CFM/min/sq. ft. (.00003 m<sup>3</sup>/sm<sup>2</sup>) of wall area at 6.24 PSF (300 Pa) as measured in accordance with ASTM E283.
2. Water Resistance: No water leakage when measured in accordance with ASTM E331 with a static test pressure of 8 PSF(383 Pa).

3. Limit mullion windload deflection of L/175 with full recovery of glazing materials, when measured in accordance with ASTM E 330.
4. System shall not deflect more than 1/8" at the center point, or 1/16" at the center point of a horizontal member, once deadload points have been established.
5. System shall accommodate expansion and contraction movement due to surface temperature differential of 180 degrees F.
6. Seismic testing shall conform to AAMA recommended static test method for evaluating performance of curtain walls and storefront wall systems due to horizontal displacements associated with seismic movements and building sway.
7. Thermal Performance – When tested in accordance with AAMA 1503.1 the following results should be attained: U-Maximum .63/CRF – minimum of 59.
8. National Fenestration Rating Council (NFRC) specific application evaluation.

#### 1.09 WARRANTY

- A. Provide manufacturer's standard warranty in accordance with Section 01 78 36 Warranties.
- B. System shall be warranted against failure and/or deterioration of metals due to manufacturing process for a period of two (2) years.

### **PART 2 – PRODUCTS**

#### 2.01 MANUFACTURER

- A. Basis of Design Manufacturer: Arcadia, Inc., 2301 E Vernon, Vernon, CA.  
Telephone 323/269-7300, Fax 323/269-7390.
- B. Basis of Design Product:
  1. Arcadia, Inc., AFG451T Series.

#### 2.02 FRAMING MATERIALS AND ACCESSORIES

- A. Framing members, transition members, mullions, adaptors, and mounting: Extruded 6063-T6 aluminum alloy (ASTM B221 – Alloy G.S. 10a T6).
- B. Screws, fastening devices, and internal components: Aluminum, stainless steel, or zinc-plated steel in accordance with ASTM.A-164. Perimeter anchors shall be aluminum or steel, providing the steel is properly isolated from aluminum.
- C. Glazing Gasket
  1. Compression-type design, replaceable, molded or extruded, or ethylene propylene diene monomer (EPDM).
  2. Shall be of type that locks securely into the glazing reglet to prevent glazing gaskets from disengaging.

#### 2.03 FINISH

- A. Finish all exposed areas of aluminum and components as indicated.
  1. An Architectural Class II or I anodic coating conforming with AA-M12C22A31/AA-M12C22A41.
    - a. Anodize finish color shall be Colornodic: #11 Clear.

#### 2.04 SYSTEM FABRICATION

- A. Continuous sub-sill shall be provided under sill members to collect water infiltration and divert from the interior of the system.

- B. Framing members shall be internally reinforced and secured at head and sill as necessary for structural performance requirements, for hardware attachment, and as indicated.
- C. Fasteners shall be so located as to ensure concealment from view in the final assembly.

### **PART 3 – EXECUTION**

#### **3.01 EXAMINATIONS**

- A. Examine conditions and verify substrate conditions are acceptable for product installation.

#### **3.02 INSTALLATION**

- A. Install in accordance with approved shop drawings and manufacturers installation instructions.

#### **3.03 FIELD QUALITY CONTROL**

- A. Test the storefront for water leaks in accordance with AAMA 501.2. Conduct test in the presence of the Architect. Correct deficiencies observed as a result of this test.

**END OF SECTION**

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## SECTION 08 71 00

### DOOR HARDWARE

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes commercial door hardware for the following:
  - 1. Swinging doors.
- B. Door hardware includes, but is not necessarily limited to, the following:
  - 1. Mechanical door hardware.
  - 2. Electromechanical door hardware.
- C. Related Sections:
  - 1. Division 08 Section "Door Schedule".
  - 2. Division 08 Section "Hollow Metal Doors and Frames".
  - 3. Division 08 Section "Bullet Resistant Doors and Frame".
  - 4. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ICC/IBC - International Building Code.
  - 3. NFPA 70 - National Electrical Code.
  - 4. NFPA 80 - Fire Doors and Windows.
  - 5. NFPA 101 - Life Safety Code.
  - 6. NFPA 105 - Installation of Smoke Door Assemblies.
  - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
  - 1. ANSI/BHMA Certified Product Standards - A156 Series.
  - 2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
  - 3. ANSI/UL 294 - Access Control System Units.
  - 4. UL 305 - Panic Hardware.
  - 5. ANSI/UL 437- Key Locks.

##### 1.03 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
  2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
  3. Content: Include the following information:
    - a. Type, style, function, size, label, hand, and finish of each door hardware item.
    - b. Manufacturer of each item.
    - c. Fastenings and other pertinent information.
    - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    - e. Explanation of abbreviations, symbols, and codes contained in schedule.
    - f. Mounting locations for door hardware.
    - g. Door and frame sizes and materials.
    - h. Warranty information for each product.
  4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
    - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    - b. Complete (risers, point-to-point) access control system block wiring diagrams.
    - c. Wiring instructions for each electronic component scheduled herein.
  2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

- E. Proof of Compliance: (California located Projects): Provide a list of product(s) containing chemicals known to cause cancer or reproductive toxicity as defined by the Office of Environmental Health Hazard Assessment (OEHHA) under Proposition 65 (CA Code of Regulations, Title 27, Section 27001). The list includes the specific chemical(s), if the chemical will be exposed to consumers, the means of warning, and an illustration of the label.
- F. Informational Submittals:
  - 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- G. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

#### 1.04 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
  - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
  - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. California Building Code: Provide hardware that complies with CBC Section 11B.
  - 1. All openings as a part of an accessible route shall comply with CBC Section 11B-404.
  - 2. The clear opening width for a door shall be 32" minimum. For a swinging door it shall be measured between the face of the door and the stop, with the door open 90 degrees. There shall be no projections into it below 34" and 4" maximum projections into it between 34" and 80" above the finish floor or ground. Door closers and stops shall be permitted to be 78" minimum above the finish floor or ground. CBC Section 11B-404.2.3.
  - 3. Operable hardware on accessible doors shall comply with CBC Section 11B-309.4 and shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. Operable parts of such hardware shall be 34" minimum and 44" maximum above finish floor or ground. Where sliding doors are in the fully open position, operating hardware shall be exposed and usable from both sides.



4. Hardware (including panic hardware) shall not be provided with "nightlatch" function for any accessible doors or gates unless the following conditions are met:
  - a. Such hardware has a 'dogging' feature and is dogged during the time the facility is open.
  - b. All 'dogging' operation is performed only by employees as their job function (non-public use).
5. The force for pushing or pulling open a door shall be in accordance with CBC Section 11B-404.2.9.
  - a. Interior hinged doors, sliding or folding doors, and exterior hinged doors: 5 pounds (22.2 N) maximum. Required fire doors: the minimum opening force allowable by the DSA authority, not to exceed 15 pounds (66.7N). These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position.
  - b. The force required for activating any operable parts, such as lever hardware, or disengaging other devices shall be 5 pounds (22.2N) maximum to comply with CBC Section 11B-309.4.
  - c. The 5 pound (22.2 N) maximum force shall be validated for the size of the door used. The Building Materials Listing of the California State Fire Marshal shall indicate that the door hardware meets the 5 pound (22.2 N) force and shall also list the largest door that can be used.
6. Door closing speed shall comply with CBC Section 11B-404.2.8. Closers shall be adjusted so that the required time to move a door from an open position of 90 degrees to a position of 12 degrees from the latch is 5 seconds minimum. Spring hinges shall be adjusted so that the required time to move a door from an open position of 70 degrees to the closed position is 1.5 seconds minimum.
7. Floor stops shall not be located in the path of travel and 4" maximum from walls.
8. Thresholds shall comply with CBC Section 11B-404.2.5.
- G. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- H. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
  1. Function of building, purpose of each area and degree of security required.
  2. Plans for existing and future key system expansion.
  3. Requirements for key control storage and software.
  4. Installation of permanent keys, cylinder cores and software.
  5. Address and requirements for delivery of keys.
- I. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
  1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors.

Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

- J. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

#### 1.05 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

#### 1.06 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
1. Structural failures including excessive deflection, cracking, or breakage.
  2. Faulty operation of the hardware.
  3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
1. Ten years for mortise locks and latches.
  2. Five years for exit hardware.
  3. Twenty five years for manual overhead door closer bodies.
  4. Two years for electromechanical door hardware.

1.07 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

**PART 2 - PRODUCTS**

2.01 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.02 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity:
    - a. Two Hinges: For doors with heights up to 60 inches.
    - b. Three Hinges: For doors with heights 61 to 90 inches.
    - c. Four Hinges: For doors with heights 91 to 120 inches.
    - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
  2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
    - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
    - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
  3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
    - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
    - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
  4. Hinge Options: Comply with the following:
    - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

- a. Bommer Industries (BO).
- b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).

- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

- a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.03 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

- a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) Option.

- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

- a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
- b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

- a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC-C Series.

2.04 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

- a. Door Controls International (DC).
- b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

1. Manufacturers:

- a. Door Controls International (DC).
- b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.05 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

1. Manufacturers:

- a. Schlage (SC).

C. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Match Facility Standard.

D. Removable Cores: Provide removable cores as specified, core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

E. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

F. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Construction Keys (where required): Ten (10).
3. Construction Control Keys (where required): Two (2).
4. Permanent Control Keys (where required): Two (2).

G. Construction Keying: Provide temporary keyed construction cores.

H. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

#### 2.06 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:
  - a. Lund Equipment (LU).
  - b. MMF Industries (MM).
  - c. Telkee (TK).

#### 2.07 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Where specified, provide status indicators with highly reflective color and wording for "locked/unlocked" or "vacant/occupied" with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1" x 0.6" with a curved design allowing a 180 degree viewing angle with protective covering to prevent tampering.
2. Manufacturers:
  - a. Schlage (SC) - L9000 Series.

#### 2.08 ELECTROMECHANICAL LOCKING DEVICES

- A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed, subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below and in the hardware sets.

1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.
2. Manufacturers:
  - a. Schlage (SC) - L9000 EL/EU/RX Series.

#### 2.09 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper

fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
  4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
  5. Flush End Caps: Provide flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
  6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
    - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
  7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
  8. Rim Exit Devices: Exit device rails shall release with less than 5 pounds of pressure per the California Building Code.
  9. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
  10. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
  11. Rail Sizing: Provide exit device rails factory sized for proper door width application.
  12. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
    - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
    - b. Sargent Manufacturing (SA) - 80 Series.
- C. Tube Steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish.
1. Provide keyed removable feature where specified in the Hardware Sets.
  2. Provide stabilizers and mounting brackets as required.
  3. Provide electrical quick connection wiring options as specified in the hardware sets.
  4. Manufacturers:
    - a. Same as exit device manufacturer.

## 2.010 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
  2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
  3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
  4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
  5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
  6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Manufacturers:
    - a. Norton Door Controls (NO) - 7500 Series.
    - b. Sargent Manufacturing (SA) - 351 Series.

## 2.011 ARCHITECTURAL TRIM

### A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
  - a. Stainless Steel: 300 grade, .050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
  - a. Burns Manufacturing (BU).
  - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).



## 2.012 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
  - 1. Manufacturers:
    - a. Burns Manufacturing (BU).
    - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
  - 1. Manufacturers:
    - a. Rixson Door Controls (RF).
    - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

## 2.013 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
  - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
  - 1. Provide intumescent seals as indicated to meet UL 10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
  - 1. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
  - 2. Reese Enterprises, Inc. (RE).

#### 2.014 ELECTRONIC ACCESSORIES

- A. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

- 1. Manufacturers:

- a. Securitron (SU) - AQL Series.

#### 2.015 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

### **PART 3 - EXECUTION**

#### 3.01 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

#### 3.02 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

#### 3.03 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
  - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
  - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
  3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
  4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.
- 3.04 ADJUSTING
- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
- 3.05 CLEANING AND PROTECTION
- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.
- 3.06 DEMONSTRATION
- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.
- 3.07 DOOR HARDWARE SETS
- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
1. Quantities listed are for each pair of doors, or for each single door.
  2. The supplier is responsible for handling and sizing all products.
  3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
- B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RO - Rockwood
4. SC - Schlage
5. SA - SARGENT
6. RF - Rixson
7. NO - Norton
8. SU - Securitron
9. SH - Schlage Electronic Security
10. OT - Other

### Hardware Sets

#### Set: 1.0

Doors: E147

1	Continuous Hinge	CFM HD1	PE	
1	Continuous Hinge	CFM HD1 PT	PE	
1	Concealed Vert Rod Exit, Exit Only	43 5CH AD8610 EO	US32D	SA
1	Fail Secure Exit Device	43 5CH AD8674 ETP	US32D	SA ⚡
2	Surface Closer	CPS7500	689	NO
2		Drop Plate & Bracket as Req'd		NO
1	Threshold	Per Sill Detail		PE
1	ElectroLynx Frame Harness	QC-C1500P		MK ⚡
1	ElectroLynx Door Harness	QC-C_P		MK ⚡
1	Power Supply w/ Power Distribution Board	AQL Series x R8 E1 (as required)		SU ⚡
1	Gasketing & Astragal	By Door/Frame Manufacturer		OT
1	Card Reader & Wiring	By Security Contractor		OT

#### Set: 2.0

Doors: 153

5	Hinge (heavy weight)	T4A3786 (NRP)	US26D	MK
1	Hinge (heavy weight)	T4A3786 QCW	US26D	MK ⚡
1	Concealed Vert Rod Exit, Exit Only	12 NB 43 5CH MD8610 EO	US32D	SA
1	Fail Secure Exit Device	12 NB 43 5CH MD8674 ETP	US32D	SA ⚡

2	Surface Closer	CPS7500	689	NO
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Gasketing	S88BL		PE
1	Gasketing	5110BL		PE
1	ElectroLynx Frame Harness	QC-C1500P		MK ⚡
1	ElectroLynx Door Harness	QC-C__P		MK ⚡
1	Power Supply w/ Power Distribution Board	AQL Series x R8 E1 (as required)		SU ⚡
1	Card Reader & Wiring	By Security Contractor		OT

Notes: Door is typically closed and locked. Presenting valid credential will momentarily release lever at active leaf to allow access. In case of fire alarm or power loss, door will remain locked (fail secure). Free egress at all times.

### Set: 3.0

Doors: 100A

5	Hinge (heavy weight)	T4A3786 (NRP)	US26D	MK
1	Hinge (heavy weight)	T4A3786 QCW	US26D	MK ⚡
1	Rim Exit Device, Exit Only	12 TB 43 5CH 8810 EO	US32D	SA
1	Fail Secure Exit Device	12 LC TB 43 5CH 8876 ETP	US32D	SA ⚡
1	Rim Cylinder x Construction Core	20-057 .ICX	.626	SC
1	Mortise Cylinder x Construction Core	30-008 .ICX	.626	SC
2	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
2	Surface Closer	CLP7500 TBGN	689	NO
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Gasketing	S88BL		PE
1	Gasketing	5110BL		PE
1	ElectroLynx Frame Harness	QC-C1500P		MK ⚡
1	ElectroLynx Door Harness	QC-C__P		MK ⚡
1	Power Supply w/ Power Distribution Board	AQL Series x R8 E1 (as required)		SU ⚡
1	Card Reader & Wiring	By Security Contractor		OT

Notes: Door is typically closed and locked. Presenting valid credential will momentarily release lever at active leaf to allow access. In case of fire alarm or power loss, door will remain locked (fail secure). Free egress at all times.

Mullion & TB required for ballistic rating.

**Set: 4.0**

Doors: 100B

2	Hinge (heavy weight)	T4A3786 (NRP)	US26D	MK	
1	Hinge (heavy weight)	T4A3786 QCW	US26D	MK	⚡
1	Fail Secure Exit Device	12 LC TB 43 5CH 8876 ETP	US32D	SA	⚡
1	Rim Cylinder x Construction Core	20-057 .ICX	.626	SC	
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC	
1	Surface Closer	CLP7500 TBGN	689	NO	
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	
1	Gasketing	S88BL		PE	
1	ElectroLynx Frame Harness	QC-C1500P		MK	⚡
1	ElectroLynx Door Harness	QC-C__P		MK	⚡
1	Power Supply w/ Power Distribution Board	AQL Series x R8 E1 (as required)		SU	⚡
1	Card Reader & Wiring	By Security Contractor		OT	

Notes: Door is typically closed and locked. Presenting valid credential will momentarily release lever to allow access. In case of fire alarm or power loss, door will remain locked (fail secure). Free egress at all times.

TB required for ballistic rating.

**Set: 5.0**

Doors: 103, 108B, 124, 127, 142, 210, 227, 240, 311, 329, 345

2	Hinge (heavy weight)	T4A3786 (NRP)	US26D	MK	
1	Hinge (heavy weight)	T4A3786 QCW	US26D	MK	⚡
1	Fail Safe Exit Device	12 LC 43 5CH 8875 ETP	US32D	SA	⚡
1	Rim Cylinder x Construction Core	20-057 .ICX	.626	SC	
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC	
1	Surface Closer	7500	689	NO	
1	Door Stop	400 / 441	US26D	RO	
1	Gasketing	S88BL		PE	
1	ElectroLynx Frame Harness	QC-C1500P		MK	⚡
1	ElectroLynx Door Harness	QC-C__P		MK	⚡
1	Power Supply w/ Power Distribution Board	AQL Series x R8 E1 (as required)		SU	⚡

1 Card Reader & Wiring

By Security Contractor

OT

Notes: Door is typically closed and locked. Presenting valid credential will momentarily release lever to allow access. In case of fire alarm or power loss, door will unlock (fail safe). Free egress at all times.

**Set: 6.0**

Doors: 105A, 105B, 106A, 106B, 108A

3	Hinge (heavy weight)	T4A3786 (NRP)	US26D	MK
1	Rim Exit Device, Classroom	12 LC 43 5CH 8813 ETP	US32D	SA
1	Rim Cylinder x Construction Core	20-057 .ICX	.626	SC
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1	Surface Closer	7500	689	NO
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	S88BL		PE

**Set: 7.0**

Doors: 126, 129, 139, 140, 237

5	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Hinge, Full Mortise	TA2714 QCW	US26D	MK ⚡
1	Self Latching Flush Bolt w/Fire Bolt	2849/2949 as req'd	US32D	RO
1	Electrified Mortise Lock	L9092EL .17A .ICX	.626	SC ⚡
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1	Coordinator	2600 Series x Brackets as Req'd	Black	RO
2	Conc Overhead Stop (Med Duty)	2-X36 (as required in lieu of door stop)	630	RF
2	Surface Closer	7500	689	NO
2	Door Stop	400 / 441	US26D	RO
1	Astragal	355CS		PE
2	Silencer	608-RKW		RO
1	ElectroLynx Frame Harness	QC-C1500P		MK ⚡
1	ElectroLynx Door Harness	QC-C__P		MK ⚡
1	Power Supply	PS900 Series		SH ⚡
1	Card Reader & Wiring	By Security Contractor		OT

Notes: Door typically closed and locked. Presenting valid credential will momentarily release lever allowing entry. In case of fire alarm or power loss door will remain locked (fail secure). Free egress at

all times.

**Set: 8.0**

Doors: 114

5	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK	
1	Hinge, Full Mortise	TA2714 QCW	US26D	MK	⚡
1	Self Latching Flush Bolt w/Fire Bolt	2849/2949 as req'd	US32D	RO	
1	Electrified Mortise Lock	L9092EL .17A .ICX	.626	SC	⚡
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC	
1	Coordinator	2600 Series x Brackets as Req'd	Black	RO	
2	Surface Closer	7500	689	NO	
2	Door Stop	400 / 441	US26D	RO	
1	Gasketing	S88BL		PE	
1	Astragal	355CS		PE	
1	ElectroLynx Frame Harness	QC-C1500P		MK	⚡
1	ElectroLynx Door Harness	QC-C_P		MK	⚡
1	Power Supply	PS900 Series		SH	⚡
1	Card Reader & Wiring	By Security Contractor		OT	

Notes: Door typically closed and locked. Presenting valid credential will momentarily release lever allowing entry. In case of fire alarm or power loss door will remain locked (fail secure). Free egress at all times.

**Set: 9.0**

Doors: 145, 150, 229, 241, 252, 355, 357

2	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK	
1	Hinge, Full Mortise	TA2714 QCW	US26D	MK	⚡
1	Electrified Mortise Lock	L9092EL .17A .ICX	.626	SC	⚡
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC	
1	Conc Overhead Stop (Med Duty)	2-X36 (as required in lieu of door stop)	630	RF	
1	Surface Closer	7500	689	NO	
1	Door Stop	400 / 441	US26D	RO	
3	Silencer	608-RKW		RO	



1	ElectroLynx Frame Harness	QC-C1500P	MK	⚡
1	ElectroLynx Door Harness	QC-C_P	MK	⚡
1	Power Supply	PS900 Series	SH	⚡
1	Card Reader & Wiring	By Security Contractor	OT	

Notes: Door typically closed and locked. Presenting valid credential will momentarily release lever allowing entry. In case of fire alarm or power loss door will remain locked (fail secure). Free egress at all times.

#### Set: 10.0

Doors: 132A, 132B, 232A, 232B, 338A, 338B

2	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK	
1	Hinge, Full Mortise	TA2714 QCW	US26D	MK	⚡
1	Electrified Mortise Lock	L9092EL .17A .ICX	.626	SC	⚡
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC	
1	Conc Overhead Stop (Med Duty)	2-X36 (as required in lieu of door stop)	630	RF	
1	Surface Closer	7500	689	NO	
1	Door Stop	400 / 441	US26D	RO	
1	Gasketing	S88BL		PE	
1	ElectroLynx Frame Harness	QC-C1500P		MK	⚡
1	ElectroLynx Door Harness	QC-C_P		MK	⚡
1	Power Supply	PS900 Series		SH	⚡
1	Card Reader & Wiring	By Security Contractor		OT	

Notes: Door typically closed and locked. Presenting valid credential will momentarily release lever allowing entry. In case of fire alarm or power loss door will remain locked (fail secure). Free egress at all times.

#### Set: 11.0

Doors: 104, 107, 109

6	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK	
1	Flush Bolt	557	US26D	RO	
1	Storeroom Lock	L9080 .17A .ICX	.626	SC	
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC	
2	Surf Overhead Stop (Med Duty)	55-X36	652	RF	

2 Silencer

608-RKW

RO

**Set: 12.0**

Doors: 333

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Storeroom Lock	L9080 .17A .ICX	.626	SC
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1	Door Stop	400 / 441	US26D	RO
3	Silencer	608-RKW		RO

**Set: 13.0**

Doors: 101, 102A, 151, 253, 358

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Storeroom Lock	L9080 .17A .ICX	.626	SC
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1	Surface Closer	7500	689	NO
1	Door Stop	400 / 441	US26D	RO
3	Silencer	608-RKW		RO

**Set: 14.0**

Doors: 119, 152, 254, 359

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Storeroom Lock	L9080 .17A .ICX	.626	SC
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1	Conc Overhead Stop (Med Duty)	2-X36 (as required in lieu of door stop)	630	RF
1	Surface Closer	7500	689	NO
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	S88BL		PE

**Set: 15.0**

Doors: 121, 122, 125, 130, 134, 135, 207, 208, 211, 212, 219, 220, 221, 222, 223, 224, 225, 233, 234, 235, 236, 239, 242, 245, 246, 247, 248, 308, 309, 319, 320, 321, 322, 323, 325, 326, 327, 330, 331, 334, 340, 341, 342, 346, 347, 350, 351, 352, 353

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Entrance/Office	L9050 .17A .ICX	.626	SC
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	By Frame Manufacturer		OT

**Set: 16.0**

Doors: 120, 136, 201A, 201B, 214A, 214B, 228, 230, 302A, 302B, 312, 314A, 314B, 332, 339

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Classroom Lock	L9070 .17A .ICX	.626	SC
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	By Frame Manufacturer		OT

**Set: 17.0**

Doors: 149, 343

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Classroom Lock	L9070 .17A .ICX	.626	SC
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1	Door Stop	400 / 441	US26D	RO
3	Silencer	608-RKW		RO

**Set: 18.0**

Doors: 115, 116, 215, 216, 315, 316

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Privacy Lock x Indicator	L9040 .17A .L283-722	.626	SC
1	Surface Closer	7500	689	NO
1	Mop Plate	K1050 6" high CSK BEV	US32D	RO
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	By Frame Manufacturer		OT

**Set: 19.0**

Doors: 146, 251, 356

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Privacy Lock x Indicator	L9040 .17A .L283-722	.626	SC
1	Surface Closer	7500	689	NO
1	Mop Plate	K1050 6" high CSK BEV	US32D	RO
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	S88BL		PE

**Set: 20.0**

Doors: 112, 137, 138, 141, 203, 205, 250, 255, 304, 306, 335, 360

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Passage Latch	L9010 .17A	.626	SC
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	By Frame Manufacturer		OT

**Set: 21.0**

Doors: 102B, 123, 209, 238, 310

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Passage Latch	L9010 .17A	.626	SC
1	Door Stop	400 / 441	US26D	RO
3	Silencer	608-RKW		RO

**Set: 22.0**

Doors: 217, 218, 317, 318

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Passage Latch	L9010 .17A	.626	SC
1	Surface Closer	7500	689	NO
1	Mop Plate	K1050 6" high CSK BEV	US32D	RO
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	By Frame Manufacturer		OT

**Set: 23.0**

Doors: 117, 118

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Passage Latch	L9010 .17A	.626	SC

1	Surface Closer	7500	689	NO
1	Mop Plate	K1050 6" high CSK BEV	US32D	RO
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	S88BL		PE

**Set: 24.0**

Doors: 113

3	Hinge, Full Mortise	TA2714 (NRP)	US26D	MK
1	Passage Latch	L9010 .17A	.626	SC
1	Surface Closer	7500	689	NO
1	Door Stop	400 / 441	US26D	RO
1	Gasketing	S88BL		PE

**Set: 25.0**

Doors: E100, E111, E125, E143, E144

1	New Mortise/Rim Cylinder	Match Existing	.626	SC
1	Permanent Core	23-030 (keyway to match facility standard)	.626	SC
1		Balance of Existing Hardware to Remain		OT

**Set: 26.0**

Doors: G000

1		Existing to Remain		OT
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**Set: 27.0**

Doors: Gate 001, Gate 002, Gate 003

Description: Gate - Lock/Strike

1 Gate Hinge/Closer	Locinox Mammoth 180			
1 Storeroom Lock	L9080 .17A .ICX	.626	SC	
1 Permanent Core	23-030 (keyway to match facility standard)	.626	SC	
1 Electric Strike	1500C-LMS	630	HS	⚡
1 SMART Pac Bridge Rectifier	2005M3		HS	⚡
1 ElectroLynx Frame Harness	QC-C1500P		MK	⚡
1 Gate Box	Keedex K-BXMOR1 Series			
1	Balance of Hardware by Gate Supplier			

Notes: Gate typically closed and locked. Presenting valid credential will momentarily release electric strike allowing entry. In case of fire alarm or power loss, gate will remain locked (fail secure). Free egress at all times.

**Set: 28.0**

Doors: Gate 004, Gate 005

Description: Gate - PH

1 Gate Hinge/Closer	Locinox Mammoth 180			
1 Rim Exit Device, Storeroom	LC 19 43 5CH WP 8804 ETP	US32D	SA	
1 Rim Cylinder x Construction Core	20-057 .ICX	.626	SC	
1 Permanent Core	23-030 (keyway to match facility standard)	.626	SC	
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	
1 Gate Box	Keedex K-BX Series for Exit Device			
1	Balance of Hardware by Gate Supplier			

Notes: Mount exit device on kick plate per Architect's detail.

**END OF SECTION**

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## SECTION 08 80 00

### GLAZING

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all Material and Labor, as shown on Drawings and as specified herein, including all accessories and hardware for a timely, complete, and proper installation:

- A. High-performance architectural glass.
- B. High-performance insulating glass.

##### 1.03 STANDARDS AND REFERENCES

- A. ANSI Z97.1 – American National Standard for Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test
- B. CPSC 16 CFR 1201 – Safety Standard for Architectural Glazing Materials
- C. Glazing Publications: Comply with published recommendations of glass product manufacturers and industry organizations, including but not limited to those below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  - 1. IGMA Publication for Insulating Glass: IGMA TM-3000, Glazing Guidelines for Sealed Insulating Glass Units.
  - 2. GANA Publications: Laminated Glazing Reference Manual; Glazing Manual.
- D. ASTM International:
  - 1. ASTM C162 – Standard Terminology of Glass and Glass Products.
  - 2. ASTM C1036 – Standard Specification for Flat Glass.
  - 3. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
  - 4. ASTM C1172 – Standard Specification for Laminated Architectural Flat Glass.
  - 5. ASTM C1376 – Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
  - 6. ASTM E2188 – Standard Test Method for Insulating Glass Unit Performance.
  - 7. ASTM E2189 – Standard Test Method for Testing Resistance to Fogging in Insulating Glass Units.
  - 8. ASTM E2190 – Standard Specification for Insulating Glass Unit Performance and Evaluation.

##### 1.04 QUALITY ASSURANCE

- A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- B. Source Limitation for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.



- C. Glass Product Testing: Obtain glass test results for product test reports in Submittals Article from a qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program
- D. Safety Glazing Labeling: Permanently mark glazing with certification label indicating manufacturer's name, type of glass, glass thickness and safety glazing standard with which glass complies.
- E. Installer Qualifications: An experienced installer who has completed glazing similar in material, design and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program.

1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Provide for each glass type:
  - 1. Latest edition of manufacturer's Technical Data including structural, physical and environmental characteristics, size limitations, and special handling or installation requirements.
  - 2. Product Certificates from manufacturer.
  - 3. Product Test Reports for Tinted Float Glass, Coated Float Glass, and Insulating Glass.
  - 4. Submit two, 12"x12" samples, illustrating glass unit and coloration.
- C. Provide data, including VOC content on glazing sealant. Identify colors available.
- D. Provide shop drawings: Submit shop drawings showing layout, profiled and product components.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.
- B. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00.
- B. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during the remainder of the construction period.

1.09 WARRANTY

- A. Provide Warranty in accordance with Section 01 78 36 Warranties and Bonds.
- B. Contractor shall guarantee the work covered by this specification against all defects in material and workmanship for a period of not less than FIVE (5) years. Include coverage of sealed glass units from seal failure, interpane dusting or misting, and replacement.

## PART 2 – PRODUCTS

### 2.01 ACCEPTABLE GLASS MANUFACTURERS

- A. Insulated, Laminated, and Spandrel Glass: Vitro Architectural Glass (formerly PPG Industries), Tel: (800) 377-5267, Website: [www.vitroglazings.com](http://www.vitroglazings.com).
- B. Security Glazing: Nippon Electric Glass Company, Ltd.; Tel: (800) 426-0279.
- C. Fire-Rated Clear Window and/or Door/Sidelight Glazing: SAFTI FIRST, Tel: (888) 653-3333, Website [www.safti.com](http://www.safti.com).
- D. Spandrel Coatings: ICD High Performance Coatings, Tel: (360) 546-2286, website: [www.icdcoatings.com](http://www.icdcoatings.com).

### 2.02 GLASS MATERIALS

- A. General Performance Requirement: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.
- B. GE-1: Exterior Glazing Type 1, Insulated Glass Units.
  - 1. Unit Makeup: Double pane of 1/4" (6mm) outboard lite and 1/4" (6mm) inboard lite with edge seal; 1/2" (12mm) spacer purged with dry hermetic air; total unit thickness of 1 inch.
  - 2. Glass Strength: Tempered as required by codes or as required to meet thermal stress and wind loads.
  - 3. Coating: Low-E Coating on inside of outer layer (#2 surface).
  - 4. Tinting: As indicated on the Drawings.
  - 5. Performance values based on combination of coating and/or tint selected.
- A. GE-2: Exterior Glazing Type 2, Spandrel Glass
  - 1. Unit Makeup: Monolithic pane of 1/4" (6mm) lite.
  - 2. Glass Strength: Tempered as required by codes or as required to meet thermal stress and wind loads.
  - 3. Coating: As indicated on the Drawings.
  - 4. Tinting: As indicated on the Drawings.
  - 5. Spandrel Coating: As indicated on the Drawings.
- B. GI-1: Interior Glazing Type 1
  - 1. Unit Makeup: Monolithic pane of 1/4" (6mm) lite.
  - 2. Glass Strength: Tempered (Grade B)
  - 3. Style: Clear, Uncoated, Type I (float or plate).
- C. GI-2: Interior Glazing Type 2, Fire-Rated
  - 1. Unit Makeup: Monolithic pane as required per Fire-Rated Assembly.
    - a. Nominal thickness per Fire Rating:
      - i. 1/4" (6mm) = 20 minute
      - ii. 3/4" (19mm) = 45 minute
      - iii. 7/8" (23mm) = 60 minute

- iv. 1 7/16" (37mm) = 90 minute
    - v. 2 1/8" (54mm) = 120 minute
  - 2. Glass Strength: Tempered. Safety rated in accordance with ANSI Z97.1 and CPSC 16 CFR 1201 Cat. I & II.
  - 3. Style: Clear, float glass.
  - 4. Fire protective tested in accordance with NFPA 80, NFPA 252, NFPA 257, UL 9, UL 10B and UL10C.
- D. GI-3: Interior Glazing Type 3, Wired
- 1. Unit Makeup: Monolithic pane of 1/4" (6mm) – nominal thickness.
  - 2. Glass Strength: Safety rated in accordance with ANSI Z97.1 and CPSC 16 CFR 1201 Cat. I & II.
  - 3. Style: Clear, wired with manufacturer's standard diamond or square pattern.
  - 4. Provide fire-rated panes as required per Fire-Rated Assembly. Note: Wired glass products do not meet ASTM E119 or NFPA 251.
- E. GI-4: Interior Glazing Type 4, Laminated
- 1. Unit Makeup: 5/16" (7mm) thick Two-Ply Laminated Glass comprised of a 1/8" (3mm) outer ply, 1/8" (3mm) inner ply and an interlayer of 0.030" polyvinyl butyral (PVB) sheet. Product to be fabricated in autoclave with heat, plus pressure, free of foreign substances and air pockets.
  - 2. Glass Strength: Chemically strengthened. Safety rated in accordance with ANSI Z97.1 and CPSC 16 CFR 1201 Cat. I & II.
  - 3. Style: Clear, unless noted otherwise.
- F. GI-5: Interior Bullet-resistant Glazing (typical unless noted otherwise in separate Section)
- 1. Unit Makeup: Four-ply polycarbonate laminate comprised of a 1/8" (3mm) abrasion resistant polycarbonate sheet outer ply, two 1/2" (12mm) polycarbonate intermediate sheets, 1/8" (3mm) abrasion resistant polycarbonate sheet inner ply with a interlayer of .025 polyurethane between each ply.
  - 2. Style: Clear, unless noted otherwise.
  - 3. Ballistic rating Level 3 in accordance with UL 752.
- G. GI-6: Interior Glazing Type 6
- 4. Unit Makeup: Monolithic pane of 1/4" (6mm) lite.
  - 5. Glass Strength: Tempered (Grade B)
  - 6. Style: Frosted, Type I (float or plate).

## 2.03 GLAZING ACCESSORIES

- A. Select appropriate glazing sealants, tapes, gaskets and other glazing materials of proven compatibility with other materials that they contact. These include glass products, insulating glass unit seals and glazing channel substrates under installation and service conditions, as demonstrated by testing and field experience. Provide fire-rated products approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection rating indicated.
- B. Glazing Compound: Modified oil type, non-hardening, knife grade consistency.
- C. Butyl Sealant: Single component; Shore-A hardness of 10-20; black color; non-skinning.

- D. Acrylic Sealant: Single component, solvent curing, cured Shore hardness, non-bleeding.
- E. Silicone Sealant: Single component, non-bleeding, non-staining; capable of water immersion without loss of properties.
- F. Setting Blocks: Neoprene; 80-90 Shore A durometer hardness; 4 inch minimum long x 1/4 inch thick.
- G. Spacer Shims: Neoprene; 40-50 Shore A durometer hardness; 4 inch long on 18 inch centers for wet-glazed systems.
- H. Glazing Clips: Manufacturer's standard type.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine the area and conditions under which work of this Section will be performed and confirm site conditions are acceptable for installation of the glass.
- B. Coordinate work with other trades as needed to assure that proper substrate are provided to receive work of this Section.
- C. Verify openings for glazing are correctly sized and within tolerance.
- D. Verify surfaces of glazing channels or recesses are clean, square in plane, free of obstructions, and ready for work of this Section.
- E. Verify that a functioning weep system is present.
- F. Correct conditions detrimental to timely and proper completion of the Work.
- G. Do not proceed until unsatisfactory conditions are corrected.
- H. Beginning of installation means acceptance of conditions.

#### **3.02 PREPARATION**

- A. Protect glazing products by handling and storing units according to manufacturer's recommendations.
- B. Clean and prepare glazing channels and other framing members to receive glass.
- C. Remove coatings and other harmful materials that will prevent glass and glazing installation required to comply with performance criteria specified.
- D. Seal porous glazing channels or recesses.

#### **3.03 EXTERIOR WET METHOD (SEALANT AND SEALANT)**

- A. Place setting blocks at 1/4 points and install glass pane.
- B. Install removable stops with pane centered in space by inserting spacer shims both sides at 18-inch intervals, 1/4 inch below sightline.
- C. Fill gap between pane and stops with sealant to depth equal to bite of frame on pane, but not more than 3/8 inch below sightline.
- D. Apply sealant to uniform line, flush with sightline. Tool or wipe sealant surface with solvent for smooth appearance. Security Glazing to be sealed with security sealant as recommended by manufacturer.
- E. Drain or weep the sill of each opening to the outdoors at three points using 3/8-inch diameter weep holes or the equivalent.

3.04 INTERIOR COMBINATION METHOD (TAPE AND SEALANT)

- A. Cut glazing tape to length and install against permanent stops, project 1/16 inch above sightline.
- B. Place setting blocks at 1/4 points.
- C. Rest glass on setting blocks and push against tape to ensure full contact at perimeter of pane.
- D. Install: removable stops, spacer shims between glass, and applied stops at 18-inch intervals 1/4 inch below sightline.
- E. Fill gap between pane and applied stop with sealant to depth equal to bite of frame on pane to uniform and level line.
- F. Trim protruding tape edge.

3.05 INTERIOR WET METHOD (COMPOUND AND COMPOUND)

- A. Install glass resting on setting blocks. Install applied stop and center pane by use of spacer shims at 18-inch centers, kept 1/4 inch below sightline.
- B. Locate and secure glass pane using glaziers' clips.
- C. Fill gaps between pane and stops with glazing compound until flush with sightline.

3.06 CLEANING

- A. After installation, mark pane with an "X" by using plastic tape or removable paste.
- B. Remove glazing materials from finish surfaces.
- C. Remove labels after work is completed.
- D. Clean excess sealant or compound from glass and framing members immediately after application using solvents or cleaners recommended by manufacturers. Final cleaning and polishing shall be done prior to final inspection.
- E. Do not use scrapers or other metal tools to clean glass.
- F. Remove and replace broken, scratched, chipped or otherwise defective glass with new materials and leave the entire installation in a neat, clean, and acceptable condition.

**END OF SECTION**

## SECTION 08 91 00

### LOUVERS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Provide metal louvers and vents as required by the Drawings, as specified herein, and as needed for a timely, complete and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods for proper performance of the work of this Section.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00 Submittal Procedures.

B. Provide the following:

1. Manufacturer's Specifications and other data needed to prove compliance with the specified requirements.
2. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades.
3. Samples of the proposed products, showing profiles, joining, and finish.
4. Manufacturer's recommended installation procedures which, when accepted by the Architect, will become the basis for accepting or rejecting actual installation procedures for the Work.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

A. Comply with the requirements of Section 01 50 00.

B. Comply with Manufacturer's Standard Requirements.

##### 1.09 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

## **PART 2 – PRODUCTS**

### **2.01 METAL LOUVERS**

- A. Provide metal louvers in the arrangements and dimensions shown on the Drawings, and with the following attributes:
1. High Performance Fixed Drainage Louver, 4" deep. Frames and blades to be 6063-T5 alloy 0.081" (2.06mm) thick. Mullions to be sliding interlock type with integral internal drain. Jamb and mullion drains to be open on front face in order to direct water away from inside of louver. Blades to be one-piece extrusions with gutters designed to catch and direct water to jamb and mullion drains. Fasteners to be aluminum or stainless steel. Louvers to have framed mesh removable mill finish aluminum insect screens.
  2. Thin line Louver, 2" deep. Frames and blades to be 6063-T5 alloy 0.050" (1.27mm) thick. Fasteners to be aluminum or stainless steel. Louvers to have framed 18 x 14 aluminum 0.0123" (0.312mm) diameter mesh mill finish aluminum insect screens. All frames to be mitered at corners and reinforced with corner brackets.
  3. Finish - Kynar. 500 coating in color selected by the Architect from the manufacturer's color selections.
- B. Acceptable products:
1. High Performance Fixed Drainable Louver, Model 4097 & Thinline Louver, Model 2322A, as manufactured by Construction Specialties, Inc.
  2. Equal products of other manufacturers when accepted in advance by the Architect.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Correct conditions detrimental to timely and proper completion of the Work.
- C. Do not proceed until unsatisfactory conditions are corrected.
- D. Verify all opening dimensions in field prior to fabrication and installation of louvers.
- E. Beginning of installation means acceptance of conditions.

### **3.02 INSTALLATION**

- A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
- B. Install the work of this Section in strict accordance with the original design, the accepted Shop Drawings, and the manufacturer's recommended installation procedures as accepted by the Architect, anchoring all components firmly into position in true alignment within a tolerance of one in 1000 vertically and horizontally.
- C. Dissimilar Materials:
1. Where aluminum surfaces come in contact with metals other than stainless steel, zinc, or white bronze of small area, isolate the aluminum by one of the following methods:
    - a. Paint the dissimilar metal with a prime coat of zinc-chromate primer, followed by two coats of aluminum metal-and-masonry paint.
    - b. Paint the dissimilar metal with a coating of heavy-bodied bituminous paint.

- c. Apply a good quality sealant material between the aluminum and the dissimilar metal.
- d. Isolate the dissimilar metals with non-absorptive tape or gaskets.

3.03 CLEANING

Prior to completion of the Work, Contractor shall thoroughly clean all exposed surfaces of louvers.

- 1. Use only the cleaning materials and techniques recommended by the manufacturer of the material being cleaned.
- 2. Do not scratch or otherwise damage the finish.

**END OF SECTION**

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## SECTION 09 05 61

### MOISTURE VAPOR EMISSION CONTROL

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Pre-formed moisture suppression membrane installed over concrete subfloor as a floor covering underlayment.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- C. Coordinate the work of this section and directly related sections with concrete floor construction and repair.
- D. Coordinate the work of this section and directly related sections with finish flooring work.

##### 1.03 REFERENCES

ASTM International

- A. D2646-05- Standard test Methods for Backing Fabric Characteristics of Pile Yarn Floor Coverings
- B. D3273-00- Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
- C. D5729-97 (2004)e1 – Standard Test Method for Thickness of Nonwoven Fabrics
- D. E-96-05 – Standard Test Methods for Water Vapor Transmission of Materials
- E. F 2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
- F. F 710 - Standard Practice Preparing Concrete Floors

##### 1.04 QUALITY ASSURANCE

Comply with the Standard requirements established by Manufacturer.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: Provide data indicating any product characteristics, performance criteria, and limitations of use.
- C. Manufacturer's Current Instructions.
- D. Manufacturer's warranty registration with concrete subfloor moisture test results and building ambient air temperature and relative humidity test results.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00.

B. Comply with Manufacturer's Standard Requirements.

1.09 WARRANTY

A. Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

B. Provide Warranty duration based upon requirements of Flooring.

**PART 2 - PRODUCTS**

2.01 MANUFACTURER

Basis of Design: GCP Applied Technologies Inc. Kovara 95 & MBX (formerly VersaShield 95 & VersaShield MBX). Location: 62 Whittemore Avenue, Cambridge, MA 02140. Phone: 866-333-3726. Website: www.gcpat.com

2.02 MOISTURE SUPPRESSION SYSTEM FOR FLOORING PRODUCTS

A. Product name: Kovara 95 Flooring Underlayment and Kovara MBX Flooring Underlayment.

1. Material: Free-standing, dimensionally stable, 4-ply composite product, engineered as a moisture suppression membrane to be used on concrete floors where high moisture exists.
2. Dimensions: 144 ft. long by 5 ft. wide standard roll.
3. Mold, Mildew & Fungal Resistance, ASTM D3273: 10 rating
4. Moisture Vapor Transmission rate, ASTM E96-05: less than 0.01 g/hr/sq m

B. Accessories: Kovara Double-Sided Seam Tape

1. Application: Joining of moisture suppression underlayment seams.
2. Description: Membrane manufacturer's moisture suppression tape with double-sided pressure sensitive adhesive for use over slabs with a maximum relative humidity of 99.5 percent and maximum pH of 12.
3. Properties: Moisture suppression and adhesion per manufacturer's specifications.
4. Dimensions: 4 inch wide by 100 feet long roll.

**PART 3 - EXECUTION**

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify internal RH of the Concrete Sub Floor according to ASTM F-2170.

1. Record readings and submit with manufacturer's warranty registration.
2. Kovara 95: Do not install if relative humidity levels within the concrete exceed 95% Relative Humidity.
3. Kovara MBX: Do not install if relative humidity levels within the concrete exceed 99% Relative Humidity.

3.02 PREPARATION

New or Remedial Installation - Concrete Sub Floor:

A. Prepare floor according to Kovara 95 or Kovara MBX manufacturer's instructions including removal of existing materials on concrete surface, grinding protrusions flat, and filling low spots with water-resistant cementitious patching or leveling compound. Patch cracks greater than 1/8-in. width using VersaShield manufacturer's approved crack mending compound.

- B. Remove debris and excessive dust from the surface.

### 3.03 UNDERLAYMENT INSTALLATION

- A. Install moisture suppression membrane with smooth film side facing concrete slab.
- B. Install in accordance with membrane manufacturer's current written installation instructions.
- C. If any jobsite condition interferes with compliance with manufacturer's instructions, contact manufacturer and obtain written job-specific procedures. Notify architect or owner's representative as required in the Quality Section of this project manual describing the interfering jobsite condition and manufacturer's job-specific instructions.

### 3.04 FLOORING INSTALLATION

- A. Adhesives - Apply adhesive to mineral-coated surface of moisture suppression membrane. Use only water-based adhesives. Do not use solvent-based adhesives.
- B. Protection - Protect moisture suppression membrane from damage during flooring installation. Do not tear, rip, puncture, or delaminate membrane when applying trowel-on adhesive. Repair damaged areas according to membrane manufacturer's instructions before flooring installation. Provide continuous, intact moisture suppression membrane under entire designated flooring area.
- C. Install flooring according to flooring manufacturer's instructions
  - 1. Laminate or Engineered Wood: Install according to manufacturer's instructions for floating floors.
  - 2. Broadloom Carpet or Carpet Tiles: Adhere directly to moisture suppression membrane using carpet manufacturer's recommended adhesive.
  - 3. Vinyl Tile: Adhere directly to moisture suppression membrane using tile manufacturer's recommended adhesive.
  - 4. Ceramic Tile: Adhere only to approved surfaces - concrete, plywood, precast flooring, gypcrete, radiant heated floors, existing well-bonded vinyl, VCT, LVT, LVP, metal floors, and chemically treated or contaminated surfaces.
- D. Not approved for unitary back direct glue wide width carpet, linoleum, rubber tile, sheet vinyl, mechanically fastened solid wood.

**END OF SECTION**

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## SECTION 09 29 00

### GYPSUM BOARD

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all Gypsum Board Products, as shown on Drawings and as specified herein, including all accessories and labor for a timely, complete, and proper installation

- A. Fire-Resistance Rated Gypsum Board
- B. Mold and Moisture Resistant Gypsum Board
- C. Fire-Resistance, Mold and Moisture Resistant Gypsum Board
- D. Abuse Resistant Gypsum Board
- E. Impact Resistant Gypsum Board
- F. Cement Board

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. Comply with the Standard requirements established by Manufacturer.
- B. Abuse Resistant Gypsum Board Performance Criteria:

- 1. Classification:

- a. Surface Abrasion: Level 1-3
- b. Surface Indention: Level 1
- c. Soft Body Impact: Level 1-2

- 2. Wall Assembly Fire-Resistance Rating: locations per the drawings.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

Provide in accordance with Section 01 33 00 Submittal Procedures.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

Comply with the requirements of Sections 01 50 00.

##### 1.09 WARRANTY

Provide Standard Warranty in accordance with Section 01 78 36 Warranties and Bonds.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURER / PRODUCTS**

Basis of Design: Products of National Gypsum Company

### **2.02 FIRE-RESISTANCE RATED GYPSUM BOARD**

A. Basis of Design: Gold Bond® BRAND Fire-Shield C Gypsum Board.

B. Panel Physical Characteristics:

1. Core: Enhanced fire-resistance rated gypsum core
2. Surface paper: 100% recycled content paper on front, back and long edges
3. Long Edges: Square or Tapered at Contractor's discretion.
4. Overall thickness: 5/8 inch.
5. Panel complies with Type X requirements of ASTM C 1396 Standard Specification for Gypsum Board

### **2.03 MOLD AND MOISTURE RESISTANT GYPSUM BOARD**

A. Basis of Design: Gold Bond® BRAND XP® Gypsum Board

B. Panel Physical Characteristics

1. Core: Mold and moisture resistant gypsum core.
2. Surface paper: 100% recycled content moisture/mold/mildew resistant paper on front, back, and long edges.
3. Long Edges: Square or Tapered at Contractor's discretion.
4. Overall thickness: 5/8 inch.
5. Panel complies with requirements of ASTM C 1396 Standard Specification for Gypsum Board.
6. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

### **2.04 FIRE-RESISTANCE RATED GYPSUM BOARD WITH ENHANCED MOLD AND MILDEW RESISTANCE**

A. Basis of Design: Gold Bond® BRAND XP® Fire-Shield® C Gypsum Board

B. Type C, Panel Physical Characteristics

1. Core: Mold and moisture resistant, with enhanced fire-resistance rated gypsum core
2. Surface paper: 100% recycled content moisture/mold/mildew paper on front, back and long edges
3. Long Edges: Square or Tapered at Contractor's discretion.
4. Overall thickness: 5/8 inch.
5. Panel complies with requirements Type X of ASTM C 1396 Standard Specification for Gypsum Board
6. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

## 2.05 ABUSE RESISTANT GYPSUM BOARD

### A. Basis of Design: Gold Bond® BRAND Hi-Abuse® XP® Gypsum Board

### B. Panel Physical Characteristics

1. Core: Fire resistance rated gypsum core, with additives to enhance, surface indentation resistance and impact resistance.
2. Surface paper: Abrasion resistant, 100% recycled content moisture/mold/mildew resistant paper on front, back and long edges
3. Long Edges: Square or Tapered at Contractor's discretion.
4. Overall thickness: 5/8 inch.
5. Panel complies with Type X requirements ASTM C 1396 Standard Specification for Gypsum Board.
6. Surface Abrasion Resistance: 0.009 inch when tested in accordance with ASTM D 4977 Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion
7. Indentation Resistance: 0.132 inch when tested in accordance with ASTM D 5420 Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
8. Soft Body Impact: 210 ft-lbf when tested in accordance with ASTM E 695 Standard Method for Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading
9. Mold/Mildew Resistance: score of 10 when tested in accordance with ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

## 2.06 CEMENT BOARD

### A. Cement Backerboard

#### 1. Basis of Design: PermaBase® BRAND Cement Board

#### 2. Panel Physical Characteristics

- a. Core: Cementitious, water-durable
- b. Surface: Fiberglass mesh on front and back
- c. Long Edges: Tapered
- d. Overall Thickness: 5/8 inch.
- e. Panel complies with requirements of ASTM C 1325 Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cementitious Backer Units and ANSI A118.9
- f. Density: 72 lbs. per cu. ft.
- g. Water Absorption: Not greater than 8% when tested for 24 hours in accordance with ASTM C 473 Standard Test Methods for Physical Testing of Gypsum Panel Products

### B. Cement Board Underlayment

#### 1. Basis of Design: PermaBase® BRAND Cement Board

#### 2. Panel Physical Characteristics

- a. Core: Cementitious, water-durable



- b. Surface: Fiberglass mesh on front and back
- c. Long Edges: Tapered
- d. Overall Thickness: 1/4 inch
- e. Panel complies with requirements of ASTM C 1325 and ANSI A118.9
- f. Density: 72 lbs per cu. ft.
- g. Water Absorption: Not greater than 8% when tested for 24 hours in accordance with ASTM C 473 Standard Test Methods for Physical Testing of Gypsum Panel Products

## 2.07 HIGH IMPACT GYPSUM BOARD

### A. Basis of Design: Gold Bond® BRAND Hi-Impact® XP® Gypsum Board

- 1. Performance Criteria - Wall Assembly STC: 40
- 2. Panel Physical Characteristics
  - a. Core: Fire-resistance rated gypsum core, with additives to enhance mold/mildew resistance, surface indentation resistance, impact resistance and moisture and mold resistant
  - b. Surface paper: Abrasion resistant, 100 percent recycled content moisture/mold/mildew resistant paper on front, back and long edges
  - c. Embedded fiberglass mesh
  - d. Long Edges: Tapered
  - e. Overall thickness: 5/8 inch
  - f. Panel complies with Type X requirements of ASTM C 1396
  - g. Surface Abrasion Resistance: Classification Level 3 in accordance with ASTM C 1629
  - h. Indentation Resistance: Classification Level 1 in accordance with ASTM C 1629.
  - i. Soft Body Impact Resistance: Classification Level 3 in accordance with ASTM C 1629
  - j. Hard Body Impact Resistance: Classification Level 3 in accordance with ASTM C 1629.
  - k. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273.

## 2.08 ACCESSORY PRODUCTS

### A. Acoustical sealant

- 1. Conform to ASTM C 919 Standard Practice for Use of Sealants in Acoustical Applications
- 2. Products/Manufacturer
  - a. Grabber Acoustical Sealant GSC
  - b. STI SpecSeal Smoke N Sound Caulk
  - c. BOSS 824 Acoustical Sound Sealant

### B. Firestopping

- 1. Conform to ASTM E 90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

2. Products/Manufacturer
  - a. STI SpecSeal SSP Putty Pads
  - b. BOSS 818 Fire Rated Putty Pads
- C. Fasteners for use with 5/8 inch thick tile backer panels: As recommended by Manufacturer.
- D. Fasteners for use with Cement Board:
  1. PermaBase Cement Board Hi-Lo thread screws (No. 8).
  2. Wafer head, corrosion-resistant.
  3. Overall Thickness: As recommended by Manufacturer.
  4. For use with wood framing and complying with ASTM C 1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- E. Joint Treatment
  1. Tape - As recommended by Manufacturer:
    - a. Paper Tape: 2-1/16 inches wide.
    - b. Paper Tape: 2 inches wide with metal strips laminated along the center crease to form inside and outside corners.
    - c. Fiberglass Tape: Nominal 2 inches wide self-adhering tape.
    - d. Alkali-resistant Fiberglass Tape: Nominal 2 inches wide polymer coated alkali-resistant mesh tape.
  2. Drying Type Compound - As recommended by Manufacturer:
    - a. Ready Mix vinyl base compound.
    - b. Ready Mix vinyl base compound formulated for enhanced mold and mildew resistance.
    - c. Ready Mix vinyl base compound formulated to reduce airborne dust during sanding.
    - d. Ready Mix vinyl base topping compound for finish coating.
    - e. Ready Mix vinyl base compound for embedding joint tape, corner beads or other accessories.
    - f. Field Mix vinyl base compound.
  3. Setting Compound - As recommended by Manufacturer:
    - a. Field mixed hardening compound.
    - b. Field mixed hardening compound for fire resistance rated construction and penetrations.
  4. Joint Sealant: Conform to ASTM C920 Standard Specification for Elastomeric Joint Sealants.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas to receive gypsum products to verify conditions.
- B. Report conditions contrary to contract requirements that would prevent a proper installation.

- C. Do not proceed with the installation until unsatisfactory conditions have been corrected.
- D. Failure to call attention to defects or imperfections will be construed as acceptance and approval of the conditions.
- E. Installation indicates acceptance of the conditions with regard to conditions existing at the time of installation.

### 3.02 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840, GA-216 or GA-214.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panel not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4 to 3/8 inch (6 to 9 mm) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4 to 1/2 inch (6 to 12 mm) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

### 3.03 INSTALLATION, INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
  - 1. Regular Type: Vertical or horizontal surfaces, unless otherwise indicated.
  - 2. Type X: Where required for fire-resistance-rated assembly.
  - 3. Type C: Where required for specific fire-resistance-rated assembly indicated.
  - 4. Ceiling Type: Ceiling surfaces.
  - 5. Moisture and Mold-Resistant Type: Areas with limited exposure to water.
  - 6. High Impact Type: As indicated on Drawings.
  - 7. Abuse Resistant Type: As indicated on Drawings.
- B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
  2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    - b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
  3. On furring members, apply gypsum panels vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
  4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
  2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
  3. On furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
  4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

### 3.04 INSTALLATION, CEMENT BOARD PANELS

- A. Install in accordance with manufacturer recommendation and ANSI A108.11.
- B. Install where tile finish is indicated in the Drawings.
- C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.05 INSTALLATION, TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings and if not shown according to ASTM C 840 or GA-216 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations

1. Cornerbead: Use at outside corners, unless otherwise indicated. Install standard 90 degree cornerbeads where corner guards and chair rails are to be installed.
2. LC-Bead: Use at exposed panel edges.

3.06 FINISHING GYPSUM BOARD

- A. Typical Finish Level: Provide a Level 4 Finish with a light orange-peel texture. All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. All joint compounds shall be smooth and free from tool marks and ridges. The prepared surface shall be coated with Sheet Rock Brand First Coat Primer, or equal, prior to the application of the light orange-peel texture.
- B. Finish Level where Super Graphic is specified, shall receive a Level 5 Finish. All joints and interior angles shall have tape embedded in joint compound over all joints and interior angles. Two separate coats of joint compound shall be applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat of joint compound shall be trowel applied to the entire surface. Excess compound is to be immediately sheared off, leaving a film or skin coating of compound completely covering the paper. The surface must be smooth and free of tool marks and ridges. The prepared surface shall be covered with a drywall primer prior to the application of the final decoration.

3.07 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION**

## SECTION 09 50 00

### ACOUSTICAL CEILINGS

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all acoustical ceilings as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.
- B. Section Includes
  - 1. Acoustical ceiling panels
  - 2. Exposed grid suspension system
  - 3. Wire hangers, fasteners, main runners, cross tees, and wall angle moldings
  - 4. Perimeter Trim

##### 1.03 STANDARDS AND REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
  - 2. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
  - 3. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
  - 4. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
  - 5. ASTM C 635 Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
  - 6. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
  - 7. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
  - 8. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
  - 9. ASTM E 119 Standard Test Methods for Fire Tests of Building Construction and Material
    - a) Armstrong Fire Guard Products
  - 10. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
  - 11. ASTM E 1111 Standard Test Method for Measuring the Interzone Attenuation of Ceilings Systems
  - 12. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum

- 13. ASTM E 1264 Classification for Acoustical Ceiling Products
- B. International Building Code
- C. ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality
- D. NFPA 70 National Electrical Code
- E. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures
- F. International Code Council-Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components
- G. International Code Council-Evaluation Services Report - Seismic Engineer Report
  - 1. ESR 1308 - Armstrong Suspension Systems
- H. International Association of Plumbing and Mechanical Officials - Seismic Engineer Report
  - 1. 0244 - Armstrong Single Span Suspension System
- I. California Department of Public Health CDPH/EHLB Emission Standard Method Version 1.1 2010

#### 1.04 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.
  - 1. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
  - 2. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 Classification.
  - 3. Fire Resistance: As follows tested per ASTM E119 and listed in the appropriate floor or roof design in the Underwriters Laboratories Fire Resistance Directory
- B. Acoustical Panels: As with other architectural features located at the ceiling, may obstruct or skew the planned fire sprinkler water distribution pattern through possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and suppression systems are present.
- C. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

#### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

#### 1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.
- B. Samples: Minimum 6 inch x 6 inch samples of specified acoustical panel; 8 inch long samples of exposed wall molding and suspension system, including main runner and 4 foot cross tees.
- C. Shop Drawings: Layout and details of acoustical ceilings show locations of items that are to be coordinated with, or supported by the ceilings.
- D. Acoustical Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and

standards. For acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC, CAC, and AC.

1. If the material supplied by the acoustical subcontractor does not have an Underwriter's Laboratory classification of acoustical performance on every carton, subcontractor shall be required to send material from every production run appearing on the job to an independent or NVLAP approved laboratory for testing, at the architect's or owner's discretion. All products not conforming to manufacturer's current published values must be removed, disposed of and replaced with complying product at the expense of the Contractor performing the work.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

#### 1.08 PROJECT CONDITIONS

- A. Space Enclosure:
  1. Standard Ceilings: Do not install interior ceilings until space is enclosed and weatherproof; wet work in place is completed and nominally dry; work above ceilings is complete; and ambient conditions of temperature and humidity are continuously maintained at values near those intended for final occupancy. Building areas to receive ceilings shall be free of construction dust and debris.
  2. HumiGuard Plus Ceilings: Building areas to receive ceilings shall be free of construction dust and debris. Products with HumiGuard Plus performance and hot dipped galvanized steel, aluminum or stainless steel suspension systems can be installed up to 120°F (49°C) and in spaces before the building is enclosed, where HVAC systems are cycled or not operating. Cannot be used in exterior applications where standing water is present or where moisture will come in direct contact with the ceiling.
  3. HumiGuard Max Ceilings: Building areas to receive ceilings shall be free of construction dust and debris. Ceilings with HumiGuard Max performance can be installed in conditions up to 120°F (49°C) and maximum humidity exposure including outdoor applications, and other standing water applications, so long as they are installed with either SS Prelude Plus, AL Prelude Plus, or Prelude Plus Fire Guard XL suspension systems. Products with HumiGuard Max performance can be installed in exterior applications, where standing water is present, or where moisture will come in direct contact with the ceiling. Only Ceramaguard with AL Prelude Plus suspension system can be installed over swimming pools.

#### 1.09 EXTRA MATERIALS

- A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
  1. Acoustical Ceiling Units: Furnish quantity of full-size units equal to 5.0 percent of amount installed.
  2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.



### 1.10 WARRANTY

- A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:
  - 1. Acoustical Panels: Sagging and warping
  - 2. Grid System: Rusting and manufacturer's defects
- B. Warranty Period:
  - 1. Acoustical panels: Ten (10) years from date of substantial completion
  - 2. Suspension: Ten (10) years from date of substantial completion
  - 3. Ceiling System: Thirty (30) years from date of substantial completion
- C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

## **PART 2 - PRODUCTS**

### 2.01 MANUFACTURERS

- A. Basis of Design for Ceiling Panels, Suspension Systems & Perimeter Systems: Armstrong World Industries, Inc., Contact: Kolby Johnson, [kjohnson@armstrongceilings.com](mailto:kjohnson@armstrongceilings.com), (949) 344-8612.

### 2.02 ACOUSTICAL CEILING UNITS

- A. Acoustical Panels Type 2 (ACT-D1)
  - 1. Surface Texture: Smooth
  - 2. Composition: Mineral Fiber
  - 3. Color: Unfinished - Field Paintable
  - 4. Size: 24 in x 48 in
  - 5. Edge Profile: Square
  - 6. Noise Reduction Coefficient (NRC):
  - 7. Flame Spread: ASTM E 1264;
  - 8. Light Reflectance (LR) White Panel: ASTM E 1477;
  - 9. Recycle Content: Post-Consumer - 15% Pre-Consumer - 69%
  - 10. Material Ingredient Transparency: Health Product Declaration (HPD); Declare Label
  - 11. Life Cycle Assessment: Third Party Certified Environment Product Declaration (EPD)
  - 12. Basis of Design: INVISACOUSTICS, 1212FP No added formaldehyde as manufactured by Armstrong World Industries
- B. Acoustical Panels Type 1 (CLG-1)
  - 1. Surface Texture: Fine
  - 2. Composition: Mineral Fiber
  - 3. Color: White
  - 4. Size: 24in X 24in X 3/4in

5. Edge Profile: Beveled tegular for interface with Suprafine XL 9/16" exposed tee grid
6. Noise Reduction Coefficient (NRC): ASTM C 423; Classified with UL label on product carton, 0.75.
7. Ceiling Attenuation Class (CAC): ASTM C 1414; Classified with UL label on product carton, 35.
8. Articulation Class (AC): ASTM E 1111; N/A
9. Emissions Testing: Section 01350 Protocol, < 13.5 ppb of formaldehyde when used under typical conditions required by ASHRAE Standard 62.1-2004, "Ventilation for Acceptable Indoor Air Quality"
10. Flame Spread: ASTM E 1264; Class A (UL)
11. Light Reflectance (LR): ASTM E 1477; White Panel: Light Reflectance: 0.90.
12. Dimensional Stability: HumiGuard Plus - Temperature is between 32°F (0° C) and 120°F (49° C). It is not necessary for the area to be enclosed or for HVAC systems to be functioning. All wet work (plastering, concrete, etc) must be complete and dry.
13. Antimicrobial Protection: Bioblock - Resists the growth of mold/mildew and bacterial growth.
14. Acceptable Product: Ultima High NRC 1942HRC as manufactured by Armstrong World Industries

C. Acoustical Panels Type 2 (CLG-2)

1. Surface Texture: Smooth
2. Composition: Metal
3. Color: White
4. Size: 24" x 48"
5. Edge Profile: Square Lay-In for interface with Prelude XL 15/16" grid system
6. Perforation Option: Open Mesh
7. Noise Reduction: NA
8. Open Percentage: 70%
9. Flame Spread: ASTM E 1264, Non-Combustible
10. Dimensional Stability: Standard
11. Recycle Content: Post-Consumer -0 Pre-Consumer Waste – 25%
12. Acceptable Product: MetalWorks Mesh Trellis, 6138W24L48 as manufactured by Armstrong World Industries

D. Acoustical Panel Type 3 (CLG-3)

1. Surface Texture: Smooth
2. Composition: Metal
3. Color: Effects Poppy Seed
4. Size: 94 ½" x 4" x 1" (#8157D41); 46 ½" x 4" x 1" (#8156D41)
5. Perforation Option: M15/Unperforated
6. Noise Reduction Coefficient (NRC): N/A
7. Ceiling Attenuation Class (CAC): N/A
8. Sabin: 2.5 Sabins per panel for perforated Blades
9. Articulation Class (AC): N/A
10. Flame Spread: ASTM E 1264; Class A (HPVA)
11. Light Reflectance White Panel: ASTM E 1477; 0.77

12. Dimensional Stability: Standard
13. Recycle Content: Post-Consumer - 20% Pre-Consumer Waste - 0%
14. Acceptable Product: MetalWorks Blades - Classics, 8157D41 & 8156D41 as manufactured by Armstrong World Industries

1. Infill Metal Panel Accessories:

1. 7204 - MetalWorks Blades Attachment Clip
2. 7205 - MetalWorks Blades Alignment Device

E. Acoustical Panels Type Type 4 (CLG-4)

1. Surface Texture: Smooth
2. Composition: Fiberglass
3. Color: White
4. Size: 24IN x 24IN x 1IN and as noted on drawings
5. Edge Profile: Square Tegular for interface with Suprafine XL 9/16" exposed tee grid.
6. Noise Reduction Coefficient (NRC): ASTM C 423; Classified with UL label on product carton 0.95.
7. Ceiling Attenuation Class (CAC):
8. Sabin: N/A
9. Articulation Class (AC): ASTM E 1111; 190
10. Flame Spread: ASTM E 1264; Class A (UL)
11. Light Reflectance White Panel: ASTM E 1477; 0.88
12. Dimensional Stability: HumiGuard Plus
13. Recycle Content: Post-Consumer - 12% Pre-Consumer Waste - 59%
14. Acceptable Product: Lyra 8361PB, as manufactured by Armstrong World Industries

F. Acoustical Panels Type 6 (CLG-6)

1. Surface Texture: Fine
2. Composition: Fiberglass
3. Color: Sky
4. Size: 10" x 46" x 2" (#7246); 10" x 94" x 2" (#7248)
5. Edge Profile: Square
6. Sabin: N/A
7. Flame Spread: ASTM E 1264; Class A (IBC)
8. Light Reflectance (LR) White Panel: ASTM E 1477; 0.86
9. Dimensional Stability: Standard
10. Recycle Content: Post-Consumer - 0% Pre-Consumer - 47%
11. Basis of Design: SOUNDSCAPES Blades #7246 & #7248 as manufactured by Armstrong World Industries

## 2.03 SUSPENSION SYSTEMS

- A. Suspension System (ACT D-1): Please refer to Armstrong Installation Instructions to choose proper mounting method for each area.
- B. Suspension System (CLG-1): Components: All main beams and cross tees shall be commercial quality hot-dipped galvanized (galvanized steel, aluminum, or stainless steel) as per ASTM A 653. Main beams and cross tees are double-web steel construction with 15/16 IN type exposed flange design. Exposed surfaces chemically cleansed, capping pre-finished

galvanized steel (aluminum or stainless steel) in baked polyester paint. Main beams and cross tees shall have rotary stitching (exception: extruded aluminum or stainless steel).

1. Structural Classification: ASTM C 635 HD.
  2. Color: White and match the actual color of the selected ceiling tile, unless noted otherwise.
  3. Acceptable Product: Suprafine XL 9/16" exposed tee grid as manufactured by Armstrong World Industries, Inc.
  4. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
  5. Accessories/Edge Moldings and Trim for noted ceilings: Angle Molding, Item #7800
  6. Accessories: BERC2 seismic clips – for all perimeter suspension system attachments (restrained and unrestrained).
- C. Suspension System (CLG-2): Components: Main beams and cross tees, base metal and end detail, fabricated from commercial quality hot dipped galvanized steel complying with ASTM A 653. Main beams and cross tees are double-web steel construction with exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching.
1. Structural Classification: ASTM C 635 Heavy Duty
  2. Color: White 360 Painted
  3. Recycle Content: Post-Consumer - 23% Pre-Consumer - 7%
  4. Acceptable Product: Prelude XL 360 Painted as manufactured by Armstrong World Industries
  5. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
  6. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft annealed, with a yield stress load of at least time three design load, but not less than 12 gauge.
- D. Suspension System (CLG-3): Components: Main beams and cross tees, base metal and end detail, fabricated from commercial quality hot dipped galvanized steel complying with ASTM A 653. Main beams and cross tees are double-web steel construction with exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching.
1. Structural Classification: ASTM C 635 Heavy Duty
  2. Color: Tech Black 360 Painted
  3. Recycle Content: Post-Consumer - 23% Pre-Consumer - 7%
  4. Acceptable Product: Prelude XL 360 Painted as manufactured by Armstrong World Industries
  5. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
  6. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft annealed, with a yield stress load of at least time three design load, but not less than 12 gauge.
- E. Suspension System (CLG-4): Components: All main beams and cross tees shall be commercial quality hot-dipped galvanized (galvanized steel, aluminum, or stainless steel) as per ASTM A 653. Main beams and cross tees are double-web steel construction with 15/16 IN type exposed flange design. Exposed surfaces chemically cleansed, capping pre-finished

galvanized steel (aluminum or stainless steel) in baked polyester paint. Main beams and cross tees shall have rotary stitching (exception: extruded aluminum or stainless steel).

1. Structural Classification: ASTM C 635 HD.
  2. Color: White and match the actual color of the selected ceiling tile, unless noted otherwise.
  3. Acceptable Product: Suprafine XL 9/16" exposed tee grid as manufactured by Armstrong World Industries, Inc.
  4. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
  5. Accessories/Edge Moldings and Trim for noted ceilings:
  6. Axiom Knife Edge Trim – AXAKESTR
  7. Axiom Outside Corner – AXAKEOC
  8. Axiom Attachment Clip – AXCCLT45
  9. Axiom Splice Plate – AXSPICE2
- F. Suspension System (CLG-6): Components: Main beams and cross tees, base metal and end detail, fabricated from commercial quality hot dipped galvanized steel complying with ASTM A 653. Main beams and cross tees are double-web steel construction with exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching.
1. Structural Classification: ASTM C 635 Heavy Duty
  2. Color: White 360 Painted
  3. Recycle Content: Post-Consumer - 23% Pre-Consumer - 7%
  4. Acceptable Product: Prelude XL 360 Painted as manufactured by Armstrong World Industries
  5. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
  6. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft annealed, with a yield stress load of at least three times design load, but not less than 12 gauge.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations. (Exception: HumiGuard Max Ceilings)

#### **3.02 PREPARATION**

- A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.
- B. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.
1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

### 3.03 INSTALLATION

- A. Follow manufacturer installation instructions.
- B. Install suspension system and panels in accordance with the manufacturer's instructions, and in compliance with ASTM C 636 and with the authorities having jurisdiction.
- C. Suspend main beam from overhead construction with hanger wires spaced 4'-0" on center along the length of the main runner. Install hanger wires plumb and straight.
- D. Install wall moldings at intersection of suspended ceiling and vertical surfaces. Miter corners where wall moldings intersect or install corner caps.
- E. For reveal edge panels: Cut and reveal or rabbet edges of ceiling panels at border areas and vertical surfaces.
- F. Install acoustical panels in coordination with suspended system, with edges resting on flanges of main runner and cross tees. Cut and fit panels neatly against abutting surfaces. Support edges by wall moldings.

### 3.04 ADJUSTING AND CLEANING

- A. Replace damaged and broken panels.
- B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any ceiling products that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.
- C. Before disposing of ceilings, contact the Armstrong Recycling Center at 877-276-7876, select option #1 then #8 to review with a consultant the condition and location of building where the ceilings will be removed. The consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant will provide assistance to facilitate the recycle of the ceiling.

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## SECTION 09 54 00

### INTEGRATED CEILING ASSEMBLIES

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all integrated ceiling assemblies as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.
- B. Section includes: Acoustical ceiling panel, wire hangers, fasteners, main runners, cross tees, and wall angle moldings and perimeter trim.
- C. System Description: Continuous/Wall-to-Wall or Cloud installation

##### 1.03 STANDARDS AND REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
  - 2. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
  - 3. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
  - 4. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
  - 5. ASTM C 645 Standard Specification for Metal Suspension Systems
  - 6. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
  - 7. ASTM C754 AND C1858 All installations should be in compliance with these tests.
  - 8. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
  - 9. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
  - 10. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
  - 11. ASTM E 1111 Standard Test Method for Measuring the Interzone Attenuation of Ceilings Systems
  - 12. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation between Rooms Sharing a Common Ceiling Plenum
  - 13. ASTM E 1264 Classification for Acoustical Ceiling Products
  - 14. ASTM E3090 All references to suspension component property testing per this test method.
- B. International Building Code
- C. ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality



- D. NFPA 70 National Electrical Code
- E. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures
- F. International Code Council-Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components
- G. International Code Council-Evaluation Services Report - Seismic Engineer Report
  - 1. ESR 1289 - Armstrong Suspension Systems
- H. California Department of Public Health CDPH/EHLB Emission Standard Method Version 1.1 2010

#### 1.04 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.
- B. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
- C. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 Classification.
- D. Acoustical Panels: As with other architectural features located at the ceiling that may obstruct or skew the planned fire sprinkler pattern through possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and suppression systems are present.
- E. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers. ACOUSTIBuilt Panels are 7/8" thick.
- F. Installer Qualification: Subcontractor is an experienced Installer that has reviewed and understands the system installation instructions thoroughly. Subcontractor will follow written installation instructions and utilize approved equipment and procedures for finishing installation.

#### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

#### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.
- C. Samples: Minimum 6 inch x 6 inch samples of specified acoustical panel; 8 inch long samples of exposed wall molding and suspension system, including main runner and 4 foot cross tees.
- D. Shop Drawings: Layout and details of acoustical ceilings show locations of items that are to be coordinated with, or supported by the ceilings.
- E. Acoustical Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC, CAC, and AC.
  - 1. If the material supplied by the acoustical subcontractor does not have an Underwriter's Laboratory classification of acoustical performance on every carton,

subcontractor shall be required to send material from every production run appearing on the job to an independent or NVLAP approved laboratory for testing, at the architect's or owner's discretion. All products not conforming to manufacturer's current published values must be removed, disposed and replaced with product that complies at the expense of the Contractor performing the work.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content. Store all material within temperature limits required by manufacturer.
- C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.08 PROJECT CONDITIONS

- A. Space Enclosure:
  - 1. Building areas to receive ceilings shall be free of construction dust and debris. ACOUSTIBuilt panels should be installed in areas where the building is enclosed and the HVAC is continuously functioning. This product is not recommended for exterior applications, where standing water is present, or where moisture will come into direct contact with the ceiling.
    - a. HVAC should be designed, installed, and operated in accordance with ASHRAE Standard 62.1. It is also necessary for the area to be enclosed, for the HVAC systems to be functioning, and in continuous operations for the life of the product. Product is not intended for use where natural ventilation is part of the ventilation strategy and not recommended in areas where a differential plenum pressure exists.

1.09 MAINTENANCE DATA

- A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
  - 1. Acoustical Ceiling Units: Furnish quality of full-size units equal to 5.0 percent of amount installed.
  - 2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.

1.10 WARRANTY

- A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:
  - 1. Acoustical Panels: Manufacturer's defects in material
  - 2. Grid System: Rusting and manufacturer's defects
- B. Warranty Period:
  - 1. Acoustical panels: Ten (10) years from date of substantial completion
  - 2. Suspension: Ten (10) years from date of substantial completion

- C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

A. Basis of Design Manufacturer for Ceiling Panels, Suspension Systems, Washers & Perimeter Systems: Armstrong World Industries, Inc. Contact representative: Kolby Johnson, kjohnson@armstrongceilings.com, (949) 344-8612.

B. Basis of Design Finish

1. Joint Compound Finish by Others
2. Spray Applied Finish by Armstrong World Industries, Inc.

### **2.02 ACOUSTICAL CEILING UNITS**

A. Acoustical Panels

1. Surface Texture: Fine
2. Composition: Mineral Fiber
3. Color: White (Fine Texture Finish for ACOUSTIBuilt panels)
4. Size: 48 in x 72 in x 7/8 in - Item #2604
5. Edge Profile: Tapered edges four sides
6. Noise Reduction Coefficient (NRC): ASTM C 423; Panel 0.80 (UL), System up to 0.70
7. Ceiling Attenuation Class (CAC): ASTM C 1414; Panel 46 (UL), System up to 48
8. Sabin: N/A
9. Articulation Class (AC): ASTM E 1111
10. Flame Spread: ASTM E 1264; Class A
11. Light Reflectance (LR) White Panel: ASTM E 1477; 0.87
12. Dimensional Stability: HumiGuard Plus
13. Recycle Content: Post-Consumer and Pre-Consumer – up to 75%
14. Material Ingredient Transparency: Health Product Declaration (HPD); Declare Label
15. Life Cycle Assessment: Third Party Certified Environment Product Declaration (EPD)
16. Acceptable Product: ACOUSTIBuilt panels #2604 No added formaldehyde as manufactured by Armstrong World Industries

B. Finish

1. Joint Compound
  - a. Setting Compound: Lightweight setting-type joint compound
  - b. Joint Tape: Self-Adhesive mesh drywall joint tape
2. Spray Applied Finish – Required Product: #2605WH Fine Texture Finish for ACOUSTIBuilt panels – White as manufactured by Armstrong World Industries.

### C. Suspension Systems and Washers

1. Armstrong Drywall Suspension Systems all main beams and cross tees shall be commercial quality hot-dipped galvanized steel
  - a. Main beam: manufactured main beam- 1-1/2" knurled face with ScrewStop™ reverse hem by 1-11/16 inches high. Drywall Main Beams are factory punched with cross tee routs, hanger wire holes, and SuperLock™ main beam clip for a strong secure connection and fast accurate alignment. Both ShortSpan and Drywall Main Beams are Heavy-duty performance per ASTM C635
  - b. HD8906 - 12ft HD Drywall Main Beam 1-1/2 in
2. Cross Tees: manufactured cross tee- 1-1/2" knurled face with ScrewStop™ reverse hem by 1-1/2 inches high with factory punched cross tee routs and hanger wire holes and XL stake on clip for a strong secure connection.
  - a. XL8945P - 4ft Drywall Cross Tee
  - b. XL8965 – 6ft Drywall Cross Tee
3. Hanger wire: a Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least time three times the design load, but not less than 12-gauge.
4. Material Ingredient Transparency: Health Product Declaration (HPD); Declare Label
5. Life Cycle Assessment: Third Party Certified Environmental Product Declaration (EPD)
6. Fasteners (for Panel attachment)
  - a. #6 x1-1/4" Fine thread or sharp point self-drilling drywall screws
  - b. Grip-Plate Washer for ACOUSTIBuilt panels (1-1/4"diameter) - #2119

### D. Perimeter Systems

1. Commercial quality extruded aluminum alloy 6063 trim channel, factory finished in baked polyester paint. Commercial quality galvanized steel unfinished T-bar connection clips; galvanized steel splice plates.
  - a. Color: White
  - b. Size: 120 in X 3 in x 3 in
  - c. Recycle Content: Post-Consumer - 50% Pre-Consumer - 0%
  - d. Acceptable Product: AXIOM Angled Knife Edge for Acoustibuilt Ceilings (#AXAKEACBSTR)
2. Corner Piece:
  - a. Outside Corner: AXAKEACBOCWH
3. Axiom Accessories:
  - a. AXSPLICE - Splice Plate
  - b. AXCCLT45 – Attachment Clip

## PART 3 – EXECUTION

### 3.01 INSPECTION

- A. Prior to installation, inspect previous work of all other trades. Verify that all work is complete and accurate to the point where this installation may properly proceed in strict accordance with framing shop drawings.
- B. If framing preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. The system installation is similar to a conventional drywall installation. However, there are key differences in both material substrate and methods of finishing and installation that make this system unique. Installers should review and follow all written directions of the installation instructions and view the installation video. [Click to follow to video access.](#)
- D. Installation: In accordance with all approved plans, details, and manufacturer's installation guidelines located in the Armstrong ACOUSTIBuilt Assembly and Installation Instructions (BPLA-299099) [Click to follow to ACOUSTIBuilt Installation Instructions](#), and Drywall Grid Systems Hanging and Framing Flat Ceilings Installation Guides (BPCS3539) [Click to follow to Hanging and Framing Flat Drywall Instructions](#).
  - 1. Install seismic components if required by the building code. Seismic components to be specified on the architectural plans by the project engineer or design team.
  - 2. Suspend main beam from overhead construction with hanger wires spaced 4-0 ft. or 6-0 ft. on center along the length of the main runner. Install hanger wires plumb and straight.
  - 3. Cross tees shall be installed 16" on center
  - 4. Install wall moldings/perimeter trim at intersection of suspended ceiling and vertical surfaces
  - 5. Main runners and cross tees shall be attached at perimeter conditions
  - 6. When determining the grid layout, consider the long edges of the boards must run parallel with the cross tees.
  - 7. This system relies on a square grid system to ensure panel edges align at centers of cross tees. If the installation does not meet these squareness requirements, the panel edges may run off the grid system.
    - a. The system must be square to within 1/8" over a 48" x 48" module.
    - b. The suspension system must be leveled to within 1/4" in 10'.
  - 8. Floating perimeters must be trimmed with either Axiom® One-Piece Drywall Trim or Axiom® Classic with Bottom Trim for ACOUSTIBuilt™. Refer to the installation instructions for integration with ACOUSTIBuilt installations.

### 3.02 PREPARATION

- A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.
- B. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.
- C. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

### 3.03 INSTALLATION

- A. Follow manufacturer installation instructions. Armstrong ACOUSTIBuilt Assembly and Installation Instructions (BPLA-299099) [Click to follow to ACOUSTIBuilt Installation Instructions](#)
- B. Controls joints are required following the standards used for gypsum board listed in ASTM C840, Section 20
  - 1. Ceilings with perimeter relief cannot exceed 50 LF and 2500 SF between control joints
  - 2. Ceilings without perimeter relief cannot exceed 30 LF and 900 SF between control joints
- C. Panel joints and fasteners are finished with tape and compound to create a flat surface. While the materials used to finish ACOUSTIBuilt panels are also used to finish drywall, the procedure has unique requirements.
- D. Joint compound coverage shall be limited to preserve the acoustical performance of the panels. Compound at panel joints shall not exceed 8 inch widths. Compound applied to field fasteners shall not exceed 4 inch by 4-inch areas. All compound shall be smooth and free of tool marks and ridges. Panels are to be finished with taping knives. Production tools, including boxes, are not permitted.
- E. Sanding and inspection: Throughout the sanding process, inspect the surface frequently for flatness. Direct a light across the ceiling to highlight unevenness that requires attention.
- F. Fine Texture Finish shall be applied in 4 coat process (additional coat may be used to achieve the desired finish) as called out in the installation instructions. Fine Texture Finish for ACOUSTIBuilt is applied in multiple coats, layered to achieve a uniform appearance and acoustical performance. It is strongly encouraged to practice spraying to ensure proper calibration and technique are achieved. Refer to the installation video.
  - 1. Must be applied with an air assist spray system (refer to manufacturers installation instructions for required equipment). The Fine texture finish is not intended for use with airless spay or to be manually applied by rolling.
  - 2. See Manufactures installation instructions for correct pressure settings for spray system, finish preparation, spray calibration and spray procedure and technique.

### 3.04 ADJUSTING AND CLEANING

- A. To remove soot, dirt, and dust use a vacuum operating at low power with a soft brush or use a dry soot cleaning sponge.
- B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any ceiling products that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.
- C. Before disposing of ceilings, contact the Armstrong Recycling Center at 877-276-7876, select option #1 then #8 to review with a consultant the condition and location of building where the ceilings will be removed. The consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant will provide assistance to facilitate the recycle of the ceiling.

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## SECTION 09 65 00

### RESILIENT FLOORING AND BASE

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all Resilient Flooring and Base, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.
- B. Work includes, but not limited to these major items:
  - 1. Resilient tile flooring.
  - 2. Floor substrate surface.
  - 3. Rubber base.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

Conform to applicable code for flame rating requirements of 75 or less in accordance with ASTM E84.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Provide product data on specified products, describing physical and performance characteristics.
- C. Submit two samples, illustrating color and pattern for each floor material or base, substituted for those indicated in the Drawings.
- D. Submit manufacturer's installation instructions. When approved by the Architect, will become the basis for accepting or rejecting actual installation procedure used on the Work.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00.
- B. Store materials for three days prior to installation in area of installation to achieve temperature stability.
- C. Maintain ambient temperature required by adhesive manufacturer three days prior to, during, and 24 hours after installation of materials.

##### 1.09 OPERATION AND MAINTENANCE DATA

- A. Provide in accordance with Section 01 77 00 Project Closeout.



- B. Submit cleaning and maintenance data maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.10 EXTRA MATERIALS

- A. Provide in accordance with Section 01 77 00 Project Closeout.
- B. Provide 5% of each pattern and color of flooring and of base specified.

1.11 RECORD DRAWINGS

Not required.

1.12 WARRANTY

- A. Provide Warranty in accordance with Section 01 78 36 Warranties.
- B. Duration: Manufacturer's 10-Year Commercial Limited Warranty.

**PART 2 – PRODUCTS**

2.01 VINYL COMPOSITION TILE

Manufacturer(s), Type(s), Location(s), Color(s), and Pattern(s) as indicated on drawings.

2.02 RESILIENT SHEET

Manufacturer(s), Type(s), Location(s), Color(s), and Pattern(s) as indicated on drawings.

2.03 RESILIENT PLANK/TILE

Manufacturer(s), Type(s), Location(s), Color(s), and Pattern(s) as indicated on drawings.

2.04 BASE MATERIALS

Manufacturer(s), Type(s), Location(s), Color(s), and Pattern(s) as indicated on drawings.

2.05 FLOORING TRANSITIONS

Manufacturer(s), Type(s), Location(s), Color(s), and Pattern(s) as indicated on drawings.

2.06 OTHER ACCESSORIES

- A. Subfloor Filler: Latex cement underlayment as recommended by flooring material manufacturer.
- B. Primers and Adhesives: Waterproof; types recommended by flooring manufacturer.
- C. Sealer and Wax: Types recommended by flooring manufacturer.
- D. Provide other materials, not specifically described but required for a complete and proper installation as selected by the Contractor subject to the approval of the Architect.

**PART 3 – EXECUTION**

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that surfaces are smooth and flat with maximum variation of 1/8 inch in 10 ft. and are ready to receive work.
- C. According to Section 07 05 00, verify that concrete floors are dry to the maximum moisture content of 2.5% (two-and-one-half percent); and exhibit negative alkalinity, carbonization, or dusting. Higher moisture content will be as accepted by manufacturer in their written warranty.

- D. Correct conditions detrimental to timely and proper completion of the Work.
- E. Do not proceed until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of conditions.

3.02 PREPARATION

- A. Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes, and other defects with sub-floor filler.
- B. Apply, trowel, and float filler to leave smooth, flat, hard surface.
- C. Prohibit traffic from area until filler is cured.
- D. Vacuum clean substrate.
- E. Maintain the temperature of the space to receive the flooring and the materials to be installed at a minimum of 65 degrees F and maximum of 100 degrees F for at least 48 hours prior to, during, and 48 hours after installation. Maintain a minimum temperature of 55 degrees F thereafter.
- F. Install flooring after all other trades, including painting, have been completed.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions, conventional full-spread system.
- B. Spread only enough adhesive to permit installation of materials before initial set.
- C. Set flooring in place; press with heavy roller to attain full adhesion.
- D. Terminate flooring at centerline of door openings where adjacent floor finish is dissimilar.
- E. Install edge strips at unprotected or exposed edges, and where flooring terminates.
- F. Scribe flooring to walls, columns, permanent cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 INSTALLATION -- BASE MATERIAL

- A. Fit joints tight and vertical. Maintain minimum measurement of 18 inches between joints.
- B. Miter internal corners. At external corners, "V" cut back of base strip to 2/3 of thickness and fold.
- C. Install base on solid backing. Bond tight to wall and floor surfaces.
- D. Scribe and fit to doorframes and other interruptions.

3.05 PROTECTION

Prohibit traffic on floor finish for 48 hours after installation.

3.06 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean, seal, and wax floor and base surfaces in accordance with manufacturer's instructions.

**END OF SECTION**

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## SECTION 09 68 00

### CARPETING

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Furnish all Materials and perform labor required to execute this work as indicated on the drawings, as specified and as necessary to comply with the Contract Documents, including, but not limited to, these major items:

- A. Direct glue down carpet with backing.
- B. Metal edge trim and backing for carpet covered wall base if indicated on the drawings.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

Comply with the Standard requirements established by Manufacturer.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Submit the following:
  - 1. Product data on specified products, describing physical and performance characteristics: sizes, patterns, colors available, and method of installation.
  - 2. Samples illustrating color and pattern for each carpet material specified if substituting from color board.
  - 3. Manufacturer's installation instructions. When approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on this Work.
  - 4. Acceptance of conditions of testing of Flooring Substrate for requirements prior to installation according to Section 07 05 00.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00.
- B. Store materials for three days prior to installation in area of installation to achieve temperature stability.
- C. Maintain minimum 72 degrees F ambient temperature plus/minus 5 degrees with relative humidity not exceeding 65% three days prior to, during, and 72 hours after installation of materials.

##### 1.09 OPERATION AND MAINTENANCE DATA

- A. Provide in accordance with Section 01 77 00 Project Closeout.

- B. Submit operation and maintenance data maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning and shampooing.

1.10 EXTRA MATERIALS

- A. Provide in accordance with Section 01 77 00 Project Closeout.
- B. Provide an extra 5% of carpeting of each color specified.

1.11 RECORD DRAWINGS

Not required.

1.12 WARRANTY

- A. Provide Warranty in accordance with Section 01 78 36 Warranties.
- B. Provide Manufacturer's Lifetime Commercial Limited Warranty.

**PART 2 – PRODUCTS**

2.01 CARPET

Manufacturer(s), Type(s), Location(s), Pattern(s), and Color(s) as indicated on drawings.

2.02 FLOORING TRANSITIONS

Manufacturer(s), Type(s), Location(s), Finishes(s), as indicated on drawings.

2.03 OTHER ACCESSORIES

- A. Sub-Floor Filler: White premix latex; type recommended by carpet manufacturer.
- B. Primers and Adhesives: Waterproof; of types recommended by carpet manufacturer.

**PART 3 – EXECUTION**

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Correct conditions detrimental to timely and proper completion of the Work.
- C. Verify that substrate surfaces are smooth and flat with maximum variation of 1/8 inch in 10 ft. and are ready to receive work. Have all previous adhesives removed.
- D. Concrete Slab Testing:
  - 1. Alkalinity: Test the concrete for alkalinity prior to beginning the installation. Check the concrete for surface pH at several locations. A reading below 5.0 or above 9.0 requires corrective measures. Specific information on the correct method of neutralizing low or high pH is available through Shaw Technical Services Department.
  - 2. Moisture: Check the concrete for moisture at several locations using the anhydrous calcium test kits. The moisture transmission rate must not exceed 5.0 pounds per 1000 square-feet per 24-hours. Do not begin the installation if an unacceptable moisture level is detected. Do not use other methods of moisture testing as they are not reliable. If excessive moisture is present, advise the Construction Manager.
- E. Do not proceed until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of conditions.

3.02 PREPARATION

- A. Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes, and other defects with

sub-floor filler.

- B. Apply, trowel, and float filler to leave smooth, flat, hard surface.
- C. Prohibit traffic until filler is cured.
- D. Vacuum floor surface.

### 3.03 INSTALLATION

- A. Apply carpet and adhesive in accordance with manufacturers' instructions. Direct glue-down.
- B. Lay out rolls of carpet.
- C. Verify carpet match before cutting to ensure minimal variation between dye lots.
- D. Locate seams in area of least traffic. Carpet shall be installed in full lengths wherever possible.
- E. Fit seams straight, not crowded or peaked, free of gaps.
- F. Lay carpet on floors with run of pile in same direction as anticipated traffic. Lay carpet so that seams perpendicular to a wall do not occur at door openings in that wall.
- G. Do not change run of pile in any room where carpet is continuous through a wall opening into another room. Locate change of color or pattern between rooms under door centerline.
- H. Cut and fit carpet around interruptions.
- I. Fit carpet tight to intersection with vertical surfaces without gaps.
- J. All seams shall be beaded and sealed with "seam sealer". The seam sealer shall be applied to the cut edge of the carpet at the level of the carpet backing.
- K. No stretching will be permitted.
- L. Unroll carpet face up and cut the lengths required with pile-lay runs in the same direction. Check starting wall for squareness and allow for off-square walls. Strike chalk line the entire length of area where seam falls.
- M. Place two lengths in proper position for installing, trim salvage, and line up seam edge with chalk line. Lay carpet perfectly flat and tension free.
- N. Roll both widths back 3' from seam area the entire length of carpet.
- O. Spread adhesive from approximate center towards each end.
- P. When sufficient floor area has been covered with adhesive, drop or roll first width into place. Apply coating of edge sealer to seam edge of first width. Follow this procedure on each succeeding width at seam. Drop or roll second width into position and fit the seam in tightly using knee-kicker if necessary. Brush or roll looseness and air bubbles away from seam.
- Q. Fold or roll the remaining portion of the first width from the wall. Apply adhesive to the floor and drop or roll carpet into place.
- R. Roll or fold back dry portion of second width towards seam; spread adhesive and place carpet 3' from where next seam will fall.
- S. Brush or roll out looseness and air bubbles as carpet is put into place. Repeat above procedure on continuing widths. Trim carpet at wall using razor blade knife or suitable wall trimmer.

### 3.04 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean and vacuum carpet surfaces.

3.05 PROTECTION

- A. Prohibit traffic from carpet areas for 24 hours after installation.
- B. Cover with non-staining building paper, firmly fastened down to protect floor surfaces.
- C. Near completion of the project, remove paper, clean and vacuum carpet.

**END OF SECTION**

NOT FOR BID

## SECTION 09 80 00

### ACOUSTICAL WALLS

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

A. Supply and install Acoustical wall panels and fasteners, as shown on Drawings and as specified here in, including all materials and labor for a timely, complete, and proper installation.

B. System Description: Wall applied

##### 1.03 STANDARDS AND REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
2. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
3. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
4. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
5. ASTM E 1264 Classification for Acoustical Ceiling Products

B. International Building Code

C. ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality

D. NFPA 70 National Electrical Code

E. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures

F. International Code Council-Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components

G. California Department of Public Health CDPH Standard Method Version 1.2 2017

##### 1.04 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.

1. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
2. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 Classification.

B. Acoustical Panels: As with other architectural features located at the ceiling, may obstruct or skew the planned fire sprinkler water distribution pattern through possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire



protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and suppression systems are present.

- C. Coordination of Work: Coordinate acoustical wall work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

#### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

#### 1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each type of acoustical wall unit.
- B. Samples: Minimum 6 inch x 6 inch samples of specified acoustical panel; 8 inch long samples of exposed wall molding.
- C. Shop Drawings: Layout and details of acoustical walls show locations of items that are to be coordinated with, or supported by the acoustical wall.
- D. Acoustical Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC.
  - 1. If the material supplied by the acoustical subcontractor does not have an Underwriter's Laboratory classification of acoustical performance on every carton, subcontractor shall be required to send material from every production run appearing on the job to an independent or NVLAP approved laboratory for testing, at the architect's or owner's discretion. All products not conforming to manufacturer's current published values must be removed, disposed of and replaced with complying product at the expense of the Contractor performing the work.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver acoustical wall units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical wall units, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical wall units carefully to avoid chipping edges or damaged units in any way.

#### 1.08 PROJECT CONDITIONS

Comply with the manufacturer's standard requirements.

#### 1.09 EXTRA MATERIALS

- A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
  - 1. Acoustical Wall Units: Furnish quality of full-size units equal to 5.0 percent of amount installed.

#### 1.10 WARRANTY

- A. Acoustical wall panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:
  - 1. Acoustical wall panels: Sagging and warping

B. Warranty Period:

1. Acoustical panels: Ten (10) years from date of substantial completion

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Basis of Design Manufacturer of Wall Panels: Armstrong World Industries, Inc.

### **2.02 ACOUSTICAL WALL UNITS**

A. Acoustical Panels Type AP

1. Surface Texture: Smooth
2. Composition: Mineral Fiber
3. Color: White
4. Size: 24"x48"x3/4"
5. Edge Profile: Square Edge
6. Noise Reduction Coefficient (NRC): ASTM C 423; Classified with UL label on product carton 0.70 with A mounting
7. Flame Spread: ASTM E 1264; Class A (UL)
8. Dimensional Stability: HumiGuard Plus
9. Basis of Design Product: Invisacoustics Walls as manufactured by Armstrong World Industries

- B. Accessories: Recommended adhesive – Titebond GREENchoice Acoustical ceiling tile adhesive

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

### **3.02 PREPARATION**

Coordinate panel layout with mechanical and electrical fixtures.

### **3.03 INSTALLATION**

- A. Follow manufacturer installation instructions.
- B. Replace damaged and broken panels.
- C. Clean exposed surfaces of acoustical walls. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any ceiling products that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.
- D. Before disposing of walls, contact the Armstrong Recycling Center at 877-276-7876, select option #1 then #8 to review with a consultant the condition and location of building where the

walls will be removed. The consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant will provide assistance to facilitate the recycle of the walls.

**END OF SECTION**

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## SECTION 09 84 33

### ACOUSTICAL WALL PANELS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

A. Supply and install all Acoustical Wall Panels, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.

B. Section includes, but is not limited to:

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

Provide in accordance with Section 01 33 00 Submittal Procedures.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

A. Comply with Manufacturer's Standard Requirements.

##### 1.09 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties & Bonds.

#### **PART 2 – PRODUCTS**

##### 2.01 MANUFACTURER

A. Basis of Design Manufacturer: Acoustical Art Concepts; 391 Hickory Street, Mount Airy, NC 27030; Phone (336)786-6254; Web <https://acousticalartconcepts.com>; Contact [josh@interlam-design.com](mailto:josh@interlam-design.com)

##### 2.02 PRODUCT

A. Basis of Design Product: Akupanel 1x025s

1. Composition: Black PET Polyester Fiber, Black thru colored MDF and real wood veneer.
2. Panel Size: 24 inches x 96 inches x 13/16 inches
3. Finish: As indicated in the Drawings.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Notify the Construction Manager and Architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- C. Correct conditions detrimental to timely and proper complete of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

### **3.02 INSTALLATION**

- A. Install panels on walls as recommended by the manufacturer in locations as indicated on the Drawings.

**END OF SECTION**

## SECTION 09 90 00

### PAINTING

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all Painting, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.
- B. Section Includes: Painting and finishing of all interior and exterior items and surfaces, unless otherwise indicated or listed under exclusions below:
  - 1. Paint all exposed surfaces, except as otherwise indicated, whether or not colors are designated.
  - 2. Include field painting of exposed exterior and interior structural steel, plumbing, mechanical and electrical work, except as indicated below.
  - 3. Paint exterior plaster where indicated on Drawings.
- C. Work Included:

The intent and requirements of this section is that all work, items and surfaces which are normally painted and finished in a building of this type and quality, shall be so included in this contract, whether or not said work, item or surface is specifically called out and included in the schedules and notes on the drawings, or is, or is not, specifically mentioned in these specifications.
- D. The following general categories of work and items that are included under other sections, shall not be a part of this section:
  - 1. Shop prime painting of structural and miscellaneous iron or steel.
  - 2. Shop prime painting of hollow metal work.
  - 3. Shop finished work and items.
  - 4. Any drywall or plaster permanently concealed from view.
  - 5. Any factory finished equipment and other materials with a complete factory applied finish.
  - 6. Finish hardware except where primed for paint finish.
  - 7. Any glass, plastics, floor tiles and sheet vinyl coved or vinyl top set bases.
  - 8. Plumbing fixtures: Toilet room accessories.
  - 9. Lighting fixtures except as noted on drawings or specified.
  - 10. Any acoustical surfaces; unless otherwise specified.
- E. The Room Finish Schedules indicated on the drawings, indicates the location of interior room surfaces to be painted or finished. The schedule indications are general and do not necessarily define the detail requirements. Include all detailed refinements and further instructions as may be given for the required complete finishing of all spaces and rooms.

##### 1.03 STANDARDS AND REFERENCES

- A. Regulatory Requirements: Comply with applicable codes and regulations of governmental agencies having jurisdiction including those having jurisdiction over airborne emissions and industrial waste disposal. Where those requirements conflict with this Specification, comply with the more stringent provisions.

- B. Regulatory changes may affect the formulation, availability, or use of specified coatings. Confirm availability of coatings to be used prior to job going out to bid and before start of painting project.
- C. Comply with the current applicable regulations of the California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD). Field Sample: When and as directed by the Architect, apply one complete coating system for each color, gloss and texture required. When approved, the sample panel areas will be deemed incorporated into the Work and will serve as the standards by which the subsequent Work of this Section will be judged.

1.04 QUALITY ASSURANCE

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Materials List: Submit complete lists of materials proposed for use, giving the manufacturer's name, catalog number, and catalog cut for each item when applicable. When required, provide a list of paint and coating materials proposed for use, which equates such materials with the design-basis products specified.
- C. Samples: Submit, on 8-1/2 inch by 11 inch hardboard, samples of each color, gloss, texture and material selected by the Architect from standard colors available for the coatings required. For natural and stained finishes, provide sample on each type and quality of wood used on the project.
- D. Manufacturer's Instructions: Submit the manufacturer's current recommended methods of installation, including relevant limitations, safety and environmental cautions, application rates, and composition analysis.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.
- B. Storage and Protection: Use all means necessary to protect the materials of this Section before, during, and after installation.
- C. Deliver materials to job site in new, original, and unopened containers bearing manufacturer's name and trade name. Store where directed in accordance with manufacturer's instructions.

1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00.
- B. Do not apply exterior materials during fog, rain or mist, or when inclement weather is expected within the dry time specified by the manufacturer. No exterior or interior painting shall be done until the surfaces are thoroughly dry and cured. Do not apply paint when temperature is below 50° F. Avoid painting surfaces when exposed to direct sunlight.

1.09 OPERATION AND MAINTENANCE DATA

- A. Provide in accordance with Section 01 77 00 Project Closeout.
- B. Coating Maintenance Manual: Provide a S-W Custodian or similar coating maintenance manual including area summary with finish schedule, area detail designating location where

each product/color/finish was used, product data pages, material safety data sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.

1.10 EXTRA MATERIALS

- A. Provide in accordance with Section 01 77 00 Project Closeout.
- B. Provide 5% with a minimum of one gallon of each color and product used.

1.11 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 – PRODUCTS**

2.01 MANUFACTURERS

- A. Basis of Design: Sherwin Williams. Architectural representative: Rocky Berlanga; Phone (657) 269-0922 or Email rocky.m.berlanga@sherwin.com.
- B. Acceptable Manufacturers: Architect/owner approved equal.
- C. All paint systems shall be the product of a single manufacturer.

2.02 MATERIALS

- A. Paints: Provide Ready-Mixed, except field catalyzed coatings. Pigments shall be fully ground maintaining soft paste consistency, capable of being readily and uniformly dispersed to complete homogeneous mixture. Paints shall have good flowing and brushing properties and be capable of drying or curing free of streaks and sags. Finish coats shall not be thinned without Architect's approval.
- B. Accessory Materials: Linseed oil, shellac, solvents, and other materials not specified but required to achieve required finishes shall be of high quality and approved by manufacturer.
- C. Colors shall be selected from color chip samples provided by manufacturer of paint system approved for use. Match approved samples for color, texture and coverage.
- D. Number of coats scheduled is minimum. Additional coats shall be applied at no additional cost if necessary to completely hide base materials, produce uniform color and provide satisfactory finish result.

2.03 MIXES

Mix, prepare, and store painting and finishing materials in accordance with manufacturer's directions.

**PART 3 – EXECUTION**

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Examine surfaces to be painted before beginning painting work. Work of other trades that has been left or installed in a condition not suitable to receive paint, stain, other specified finish shall be repaired or corrected by the applicable trade before painting. Painting of defective or unsuitable surface implies acceptance of the surfaces.
- C. Do not proceed with surface preparation or coating application until conditions are suitable. Special attention should be made to all smooth and especially Level 5 Drywall Finish areas. In those instances, a test patch to ensure proper surface adhesion should be undertaken.



- D. Beware of a condition known as "critical lighting". This condition causes shadows that accentuate even the slightest surface variations. A pigmented sealer will provide tooth for succeeding decorative coating, but "does not" equalize smoothness or surface texture. Any corrective action to gypsum board/drywall must be done by the drywall contractor prior to decorating.
- E. Notify the Construction Manager and Architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- F. Correct conditions detrimental to timely and proper completion of the Work.
- G. Do not proceed until unsatisfactory conditions are corrected.
- H. Beginning of installation means acceptance of conditions.

### 3.02 PROTECTION

- A. Protect previously installed work and materials, which may be affected by Work of this Section.
  - 1. Protect prefinished surfaces, lawns, shrubbery and adjacent surfaces against paint and damage.
  - 2. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or splatter from fouling surfaces not being painted.
  - 3. Protect surfaces, equipment, and fixtures from damage resulting from use of fixed, movable and hanging scaffolding, planking, and staging.
- B. Provide WET PAINT signs, barricades, and other devices required to protect newly finished surfaces. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

### 3.03 PREPARATION

- A. Perform preparation and cleaning procedures in strict accordance with coating manufacturer's instructions for each substrate condition.
- B. Concrete and masonry surfaces shall be dry, clean, and free of dirt, efflorescence, encrustation, and other foreign matter. Glazed surfaces on concrete shall be roughened or etched to uniform texture.
- C. Ferrous metal shall be cleaned per SSPC-SP1. All welds, loosely adhered rust, and debris must be power tool cleaned per SSPC-SP3. Prime within 3 hours after preparation.
- D. Clean per SSPC-SP1 to remove greases and oils. Apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, power tool clean per SSPC-SP3 to remove these treatments.
- E. Remove dust, grit and foreign matter from wood surfaces. Sand surfaces and dust clean. Spot coat knots, pitch streaks, and sappy section with pigmented stain sealer when surfaces are to be painted. Fill nail holes, cracks and other defects after priming and spot prime repairs when fully cured.
- F. Remove hardware and accessories, machined surfaces, plates, lighting fixtures and similar items in place and not-to-be-finish painted, or provide surface-applied protection. Reinstall removed items upon completion of work in each area.
- G. Existing surfaces to be recoated shall be thoroughly cleaned and de-glossed by sanding or other means prior to painting. Patched and bare areas shall be spot primed with same primer as specified for new work.
- H. Thoroughly backpaint all surfaces of all finish lumber and millwork, including doors and window frames, trim, cabinetwork, etc., which will be concealed after installation. Backpaint

items to be painted or enameled with the priming coat. Use a clear sealer for backpriming where transparent finish is required.

- I. Bar and covered pipes, ducts, hangers, exposed steel and ironwork, and primed metal surfaces of equipment installed under mechanical and electrical work shall be cleaned prior to priming.
- J. Preparation of other surfaces shall be performed following specific recommendations of the coatings manufacturer.
- K. Bond breakers and curing agents must be removed and the surface cleaned before primers, sealers or finish paints can be applied.
- L. All drywall surfaces must be completely dry and dust free before painting. Skim coated drywall must be sealed with an alkyd based sealer or a waterborne sealer recommended by the paint manufacturer for this surface. Use the appropriate light or medium tack masking tape.
- M. Do not apply initial coating until moisture content of surface is within limitations recommended by the paint manufacturer.
- N. Do not paint over Underwriters' labels, fusible links or sprinkler heads.

#### 3.04 APPLICATION

- A. Apply painting and finishing materials in accordance with the manufacturer's submittals, as approved. Use applicators and techniques best suited for the material and surfaces to which applied.
  - 1. The number of coats specified is the minimum that shall be applied. Apply additional coats when undercoats, stains or other conditions show through final paint coat, until paint film is of uniform finish, color and appearance.
  - 2. Apply prime coat to surfaces which are required to be painted or finished. All undercoats shall be tinted slightly to approximate the color of the finish coat.
- B. All materials shall be applied evenly with proper film thickness and free of runs, sags, skips and other defects. Apply each material at not less than the manufacturer's recommended spreading rate: Provide a total dry film thickness of not less than 1.2 mils for each required coat.
- C. Sand lightly and dust clean between succeeding coats. Comply with recommendations of manufacturer for drying time between succeeding coats.
- D. Make edges of paint adjoining other material or color clean and sharp with no overlapping.
- E. Refinish entire wall where portion of finish is not acceptable.

#### 3.05 CLEANING, TOUCH-UP AND REFINISHING

- A. Carefully remove all spattering, spots and blemishes caused by work under this section from surfaces throughout the project.
- B. Upon completion of painting work remove all rubbish, paint cans, and accumulated materials resulting from work in each space or room. All areas shall be left in a clean, orderly condition.
- C. Runs, sags, misses, holidays, stains and other defects in the painted surfaces, including inadequate coverage and mil thickness shall be satisfactorily touched up, or refinished, or repainted as necessary.

#### 3.06 FINISH SCHEDULE

- A. Apply the following finishes to the surfaces specified and/or as on the finish schedule and plans in the Drawings. Apply all materials in accordance with manufacturer's instructions on

properly prepared surfaces and foundation coats. All intermediate undercoats must be tinted to approximate the final color.

B. Exterior Systems:

1. Stucco & Plaster

a. Flat – 100% Acrylic

First Coat	Loxon Primer LX2W50
Second Coat	A-100 Exterior Latex Flat A6 Series
Third Coat	A-100 Exterior Latex Flat A6 Series

b. Semi-transparent Stain

First Coat	Loxon Vertical Semi-transparent Stain LX31T75
Second Coat	Loxon Vertical Semi-transparent Stain LX31T75
Third Coat	Loxon Vertical Semi-transparent Stain LX31T75

2. Ferrous Metal

a. Flat – Acrylic

First Coat	ProCryl Universal Acrylic Metal Primer B66-310
Second Coat	A-100 Exterior Latex Flat A6 Series
Third Coat	A-100 Exterior Latex Flat A6 Series

b. Semi-Gloss – Acrylic

First Coat	ProCryl Universal Acrylic Metal Primer B66-310
Second Coat	Solo Acrylic Latex Semigloss A76 Series
Third Coat	Solo Acrylic Latex Semigloss A76 Series

c. Gloss – Acrylic

First Coat	ProCryl Universal Acrylic Metal Primer B66-310
Second Coat	Solo Acrylic Latex Gloss A77 Series
Third Coat	Solo Acrylic Latex Gloss A77 Series

d. Gloss – Rust Preventative Acrylic

First Coat	ProCryl Universal Acrylic Metal Primer B66-310
Second Coat	ProIndustrial Acrylic Gloss B66-600 Series
Third Coat	ProIndustrial Acrylic Gloss B66-600 Series

e. Gloss, Industrial High Performance – Inorganic Zinc/Epoxy/Acrylic

First Coat	ZincClad III HS-100 B69 Series
Second Coat	Macropoxy 646-100 B58 Series
Third Coat	ProIndustrial Acrylic Gloss B66-600 Series, Coat to Cover

f. Low Sheen, Industrial High Performance – Epoxy Primer/Epoxy/Acrylic (VOC compliant in SCAQMD)

First Coat	Macropoxy 646-100 B58 Series
Second Coat	Macropoxy 646-100 B58 Series
Third Coat	ProIndustrial Acrylic Eg-shel B66-660 Series, Coat to cover

g. High Gloss, Industrial High Performance – Inorganic Zinc/Epoxy/Urethane (VOC compliant in SCAQMD)

First Coat	ZincClad III HS-100 B69 Series
Second Coat	Macropoxy 646-100 B58 Series
Third Coat	Acrolon 100 WB Polyurethane B65 Series, Coat to Cover

h. High Gloss, Industrial High Performance – Epoxy Primer/Epoxy/Urethane (VOC compliant in SCAQMD)

First Coat	Macropoxy 646-100 B58 Series
------------	------------------------------

Second Coat	Acrolon 100 WB Polyurethane B65 Series
Third Coat	Acrolon 100 WB Polyurethane B65 Series
3. <u>Galvanized Metal</u>	
a. Flat – Acrylic	
Pretreatment	GLL Clean n Etch
First Coat	ProCryl Universal Acrylic Metal Primer B66-310
Second Coat	A-100 Exterior Latex Flat A6 Series
Third Coat	A-100 Exterior Latex Flat A6 Series
b. Semi-Gloss – Acrylic	
Pretreatment	GLL Clean n Etch
First Coat	ProCryl Universal Acrylic Metal Primer B66-310
Second Coat	Solo Acrylic Latex Semigloss A76 Series
Third Coat	Solo Acrylic Latex Semigloss A76 Series
c. Gloss – Acrylic	
Pretreatment	GLL Clean n Etch
First Coat	ProCryl Universal Acrylic Metal Primer B66-310
Second Coat	Solo Acrylic Latex Gloss A77 Series
Third Coat	Solo Acrylic Latex Gloss A77 Series
d. Gloss – Rust Preventative Acrylic	
First Coat	ProCryl Universal Acrylic Metal Primer B66-310
Second Coat	ProIndustrial Acrylic Gloss B66-600 Series
Third Coat	ProIndustrial Acrylic Gloss B66-600 Series
e. Low Sheen, Industrial High Performance – Epoxy Primer/Acrylic (VOC compliant in SCAQMD)	
First Coat	Macropoxy 646-100 B58 Series
Second Coat	ProIndustrial Acrylic Eg-shel B66-660
Third Coat	ProIndustrial Acrylic Eg-shel B66-660
f. High Gloss, Industrial High Performance – Epoxy Primer/Urethane	
First Coat	Macropoxy 646-100 B58 Series
Second Coat	Acrolon 100 WB Polyurethane B65 Series
Third Coat	Acrolon 100 WB Polyurethane B65 Series
C. Interior Systems:	
1. <u>Gypsum Board</u>	
a. Flat – Acrylic	
First Coat	PVA Primer B28W8000
Second Coat	ProMar 200 Zero VOC Flat B30-2600
	<b>ProMar 200 Zero VOC Interior Latex Flat at Level 5 gypsum walls receiving vinyl graphic. Refer to Drawings.</b>
Third Coat	ProMar 200 Zero VOC Flat B30-2600
	<b>ProMar 200 Zero VOC Interior Latex Flat at Level 5 gypsum walls receiving vinyl graphic. Refer to Drawings.</b>
b. Low Sheen – Acrylic	
First Coat	PVA Primer B28W8000
Second Coat	ProMar 200 Zero VOC Low Sheen B24-2600
Third Coat	ProMar 200 Zero VOC Low Sheen B24-2600

- c. Eggshell – Acrylic
    - First Coat PVA Primer B28W8000
    - Second Coat ProMar 200 Zero VOC Eg-shel B20-2600
    - Third Coat ProMar 200 Zero VOC Eg-shel B20-2600
  - d. Semi-Gloss - Acrylic
    - First Coat PVA Primer B28W8000
    - Second Coat ProMar 200 Zero VOC Semigloss B31-2600
    - Third Coat ProMar 200 Zero VOC Semigloss B31-2600
  - e. Gloss – Acrylic
    - First Coat PVA Primer B28W8000
    - Second Coat ProMar 200 Zero VOC Gloss B21-12650
    - Third Coat ProMar 200 Zero VOC Gloss B21-12650
  - f. Gloss – Industrial High Performance – Waterborne Epoxy
    - First Coat ProMar 200 Zero VOC Primer B28W2600
    - Second Coat WB Catalyzed Epoxy Gloss B73 Series
    - Third Coat WB Catalyzed Epoxy Gloss B73 Series
  - g. High Gloss – Industrial High Performance – Waterborne Epoxy/Urethane
    - First Coat Macropoxy 646-100 B58 Series
    - Second Coat Acrolon 100 WB Polyurethane B65 Series
    - Third Coat Acrolon 100 WB Polyurethane B65 Series
2. Concrete & Plaster:
- a. Flat – Acrylic Copolymer
    - First Coat Loxon Primer LX2W50
    - Second Coat ProMar 200 Zero VOC Flat B30-2600
    - Third Coat ProMar 200 Zero VOC Flat B30-2600
  - b. Low Sheen – Acrylic Copolymer
    - First Coat Loxon Primer LX2W50
    - Second Coat ProMar 200 Zero VOC Low Sheen B24-2600
    - Third Coat ProMar 200 Zero VOC Low Sheen B24-2600
  - c. Eggshell –Acrylic Copolymer
    - First Coat Loxon Primer LX2W50
    - Second Coat ProMar 200 Zero VOC Eg-shel B20-2600
    - Third Coat ProMar 200 Zero VOC Eg-shel B20-2600
  - d. Semi-Gloss –Acrylic Copolymer
    - First Coat Loxon Primer LX2W50
    - Second Coat ProMar 200 Zero VOC Semigloss B31-2600
    - Third Coat ProMar 200 Zero VOC Semigloss B31-2600
  - e. Gloss – 100% Acrylic
    - First Coat Loxon Primer LX2W50
    - Second Coat ProMar 200 Zero VOC Gloss B21-12650
    - Third Coat ProMar 200 Zero VOC Gloss B21-12650
  - f. Gloss – Industrial High Performance - Waterborne Epoxy
    - First Coat Loxon Primer LX2W50
    - Second Coat WB Catalyzed Epoxy Gloss B73 Series
    - Third Coat WB Catalyzed Epoxy Gloss B73 Series

- g. High Gloss- Industrial High Performance - Epoxy/Urethane
  - First Coat Macropoxy 646-100 B58 Series
  - Second Coat Acrolon 100 WB Polyurethane B65 Series
  - Third Coat Acrolon 100 WB Polyurethane B65 Series

3. Brick

- a. Flat – Acrylic Copolymer
  - First Coat Loxon Primer LX2W50
  - Second Coat ProMar 200 Zero VOC Flat B30-2600
  - Third Coat ProMar 200 Zero VOC Flat B30-2600
- b. Low Sheen – Acrylic Copolymer
  - First Coat Loxon Primer LX2W50
  - Second Coat ProMar 200 Zero VOC Low Sheen B24-2600
  - Third Coat ProMar 200 Zero VOC Low Sheen B24-2600
- c. Eggshell –Acrylic Copolymer
  - First Coat Loxon Primer LX2W50
  - Second Coat ProMar 200 Zero VOC Eg-shel B20-2600
  - Third Coat ProMar 200 Zero VOC Eg-shel B20-2600
- d. Semi-Gloss –Acrylic Copolymer
  - First Coat Loxon Primer LX2W50
  - Second Coat ProMar 200 Zero VOC Semigloss B31-2600
  - Third Coat ProMar 200 Zero VOC Semigloss B31-2600
- e. Gloss – 100% Acrylic
  - First Coat Loxon Primer LX2W50
  - Second Coat ProMar 200 Zero VOC Gloss B21-12650
  - Third Coat ProMar 200 Zero VOC Gloss B21-12650
- f. Gloss – Industrial High Performance - Waterborne Epoxy
  - First Coat Loxon Primer LX2W50
  - Second Coat WB Catalyzed Epoxy Gloss B73 Series
  - Third Coat WB Catalyzed Epoxy Gloss B73 Series
- g. High Gloss- Industrial High Performance - Epoxy/Urethane
  - First Coat Macropoxy 646-100 B58 Series
  - Second Coat Acrolon 100 WB Polyurethane B65 Series
  - Third Coat Acrolon 100 WB Polyurethane B65 Series

4. Concrete Block

- a. Flat – Acrylic Copolymer
  - First Coat PrepRite Block Filler B25W25
  - Second Coat ProMar 200 Zero VOC Flat B30-2600
  - Third Coat ProMar 200 Zero VOC Flat B30-2600
- b. Low Sheen – Acrylic Copolymer
  - First Coat PrepRite Block Filler B25W25
  - Second Coat ProMar 200 Zero VOC Low Sheen B24-2600
  - Third Coat ProMar 200 Zero VOC Low Sheen B24-2600
- c. Eggshell –Acrylic Copolymer
  - First Coat PrepRite Block Filler B25W25
  - Second Coat ProMar 200 Zero VOC Eg-shel B20-2600

Third Coat ProMar 200 Zero VOC Eg-shel B20-2600

d. Semi-Gloss –Acrylic Copolymer

First Coat PrepRite Block Filler B25W25  
Second Coat ProMar 200 Zero VOC Semigloss B31-2600  
Third Coat ProMar 200 Zero VOC Semigloss B31-2600

e. Gloss – 100% Acrylic

First Coat PrepRite Block Filler B25W25  
Second Coat ProMar 200 Zero VOC Gloss B21-12650  
Third Coat ProMar 200 Zero VOC Gloss B21-12650

f. Gloss – Industrial High Performance - Waterborne Epoxy

First Coat PrepRite Block Filler B25W25  
Second Coat WB Catalyzed Epoxy Gloss B73 Series  
Third Coat WB Catalyzed Epoxy Gloss B73 Series

g. High Gloss- Industrial High Performance – Acrylic/Urethane

First Coat Heavy Duty Block Filler B42W46  
Second Coat Macropoxy 646-100 B58 Series  
Third Coat Acrolon 100 WB Polyurethane B65 Series

5. Ferrous Metal

a. Flat – Acrylic Copolymer

First Coat ProCryl Universal Acrylic Metal Primer B66-310  
Second Coat ProMar 200 Zero VOC Flat B30-2600  
Third Coat ProMar 200 Zero VOC Flat B30-2600

b. Low Sheen –Acrylic Copolymer

First Coat ProCryl Universal Acrylic Metal Primer B66-310  
Second Coat ProMar 200 Zero VOC Low Sheen B24-2600  
Third Coat ProMar 200 Zero VOC Low Sheen B24-2600

c. Eggshell –Acrylic Copolymer

First Coat ProCryl Universal Acrylic Metal Primer B66-310  
Second Coat ProMar 200 Zero VOC Eg-shel B20-2600  
Third Coat ProMar 200 Zero VOC Eg-shel B20-2600

d. Semi-Gloss – Acrylic Primer/ Acrylic Copolymer

First Coat ProCryl Universal Acrylic Metal Primer B66-310  
Second Coat ProMar 200 Zero VOC Semigloss B31-2600  
Third Coat ProMar 200 Zero VOC Semigloss B31-2600

e. Semi-Gloss –Rust Preventative Acrylic

First Coat ProCryl Universal Acrylic Metal Primer B66-310  
Second Coat ProIndustrial Acrylic SemiGloss  
Third Coat ProIndustrial Acrylic SemiGloss

f. Gloss – Acrylic Primer /100% Acrylic

First Coat ProCryl Universal Acrylic Metal Primer B66-310  
Second Coat Solo Acrylic Latex Gloss A77 Series  
Third Coat Solo Acrylic Latex Gloss A77 Series

g. Gloss –Rust Preventative Acrylic

First Coat ProCryl Universal Acrylic Metal Primer B66-310  
Second Coat ProIndustrial Acrylic Gloss

- |            |                             |
|------------|-----------------------------|
| Third Coat | ProIndustrial Acrylic Gloss |
|------------|-----------------------------|
- h. Gloss – Industrial High Performance - Waterborne Epoxy
- |             |  |
|-------------|--|
| First Coat  | ProCryl Universal Acrylic Metal Primer B66-310 |
| Second Coat | WB Catalyzed Epoxy Gloss B73 Series            |
| Third Coat  | WB Catalyzed Epoxy Gloss B73 Series            |
- i. High Gloss – Industrial High Performance - Epoxy/Urethane
- |             |  |
|-------------|--|
| First Coat  | Macropoxy 646-100 B58 Series           |
| Second Coat | Acrolon 100 WB Polyurethane B65 Series |
| Third Coat  | Acrolon 100 WB Polyurethane B65 Series |
6. Wood – Paint Finish
- a. Flat – Acrylic Copolymer
- |             |                                   |
|-------------|-----------------------------------|
| First Coat  | PrepRite ProBlock Primer B51W8020 |
| Second Coat | ProMar 200 Zero VOC Flat B30-2600 |
| Third Coat  | ProMar 200 Zero VOC Flat B30-2600 |
- b. Low Sheen – Acrylic Copolymer
- |             |  |
|-------------|--|
| First Coat  | PrepRite ProBlock Primer B51W8020      |
| Second Coat | ProMar 200 Zero VOC Low Sheen B24-2600 |
| Third Coat  | ProMar 200 Zero VOC Low Sheen B24-2600 |
- c. Eggshell – Acrylic Copolymer
- |             |                                      |
|-------------|--------------------------------------|
| First Coat  | PrepRite ProBlock Primer B51W8020    |
| Second Coat | ProMar 200 Zero VOC Eg-shel B20-2600 |
| Third Coat  | ProMar 200 Zero VOC Eg-shel B20-2600 |
- d. Semi-Gloss – 100% Acrylic
- |             |   |
|-------------|---|
| First Coat  | PrepRite ProBlock Primer B51W20         |
| Second Coat | Solo Acrylic Latex Semigloss A76 Series |
| Third Coat  | Solo Acrylic Latex Semigloss A76 Series |
- e. Semi-Gloss – Alkyd – Class A Fire Retardant
- |             |   |
|-------------|---|
| First Coat  | Please contact your Sherwin-Williams representative for |
| Second Coat | fire retardant wood finish information.                 |
| Third Coat  |   |
- f. Gloss – 100% Acrylic
- |             |                                     |
|-------------|-------------------------------------|
| First Coat  | PrepRite ProBlock Primer B51W8020   |
| Second Coat | Solo Acrylic Latex Gloss A77 Series |
| Third Coat  | Solo Acrylic Latex Gloss A77 Series |
7. Wood – Stain & Lacquer  
(VOC Rule in SCAQMD is 275 g/L for field-applied coatings)
- a. Flat
- |             |  |
|-------------|--|
| First Coat  | SherWood BAC Wiping Stain S64          |
| Filler      | Jasco Paste Wood Filler                |
| Second Coat | KemAqua Lacquer Sanding Sealer T65F520 |
| Third Coat  | KemAqua Dull Rub Clear Lacquer T75F528 |
| Fourth Coat | KemAqua Dull Rub Clear Lacquer T75F528 |
- b. Semi-Gloss
- |             |  |
|-------------|--|
| First Coat  | SherWood BAC Wiping Stain S64          |
| Filler      | Jasco Paste Wood Filler                |
| Second Coat | KemAqua Lacquer Sanding Sealer T65F520 |



Third Coat  
Fourth Coat

KemAqua Semigloss Clear Lacquer T75F526  
KemAqua Semigloss Clear Lacquer T75F526

c. Gloss  
First Coat  
Filler  
Second Coat  
Third Coat  
Fourth Coat

SherWood BAC Wiping Stain S64  
Jasco Paste Wood Filler  
KemAqua Lacquer Sanding Sealer T65F520  
KemAqua Gloss Clear Lacquer T75C525  
KemAqua Gloss Clear Lacquer T75C525

**END OF SECTION**

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## SECTION 10 14 00

### SIGNAGE

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all exterior and interior signage, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 Submittal Procedures.

B. Provide:

1. Shop Drawings: Provide shop drawings for review and approval prior to commencement of fabrication.
2. Samples: Provide to illustrate full size sample sign, of type, style and color specified including method of attachment.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

B. Package signs, labeled in name groups.

C. Store adhesive tape at ambient room temperatures.

##### 1.08 PROJECT CONDITIONS

A. Comply with the requirements of Section 01 50 00.

B. Do not install signs when ambient temperature is below 70 degrees F. Maintain this minimum during and after installation of signs.

##### 1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

##### 1.10 EXTRA MATERIALS

Provide in accordance with Section 01 77 00 Project Closeout.

##### 1.11 RECORD DRAWINGS

Provide in accordance with Section 01 77 00 Project Closeout.

1.12 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 – PRODUCTS**

2.01 MATERIALS – EXTERIOR BUILDING SIGNAGE

- A. Basis of Design: A.R.K. Ramos Architectural Signage Systems; Oklahoma City, OK 73109; Tel: (800) 725-7266. Website: www.arkramos.com
- B. Letters and/or Numbers – Font/Size/Finish/Color: as indicated in Drawings.
- C. Material: Aluminum Channel Letter
- D. Mounting: Brackets, PPM-1 bracket sleeved stud.
  - 1. Set in adhesive in masonry.
  - 2. Attach to support in framed wall.

2.02 MATERIALS – ROOM IDENTIFICATION SIGNAGE

- A. Refer to Signage Plan for types and locations.
- B. Material: 1/8" thick ES Plastic.
- C. Size and color: As indicated in Drawings
- D. Graphics: Vinyl die-cut. Font to be 3/4" Helvetic Medium, All Caps.
- E. All signage to have 1/2" radius corners
- F. Mounting: Adhesive
- G. All signs installed on glass shall have a full size backing plate adhered to the opposite side of the glass of the same color as the sign.

2.03 MATERIALS – INTERIOR ADA SIGNAGE

- A. Types and locations: As indicated in Drawings, conforming to requirements of the California Building Code.
- B. Material: 1/8" thick ES Plastic.
- C. Text and font, size and color: As indicated in Drawings
- D. Graphics: To be vinyl die-cut.
- E. All signs to have 1/2" Radius corners
- F. Mounting: Adhesive
- G. All signs installed on glass shall have a full size backing plate adhered to the opposite side of the glass of the same color as the sign.

2.04 DEDICATION PLAQUE

Refer to Drawings for location, size, text, and material details.

2.05 ACCESSORIES

- A. Mounting Hardware: Chrome screws; base sleeve and studs per manufacturer's recommendations.
- B. Tape Mount: Double sided tape, permanent adhesive.
- C. Adhesive: Silastic adhesive as recommended by manufacturer.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify adequate support for Building Signs. Coordinate footings with other trades.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install signs after doors and surfaces are finished, in locations indicated.
  - 1. Furnish and install all anchorage devices required to install the item and its appurtenances complete. Provide anchorage in ample time when required to be built in by other trades.
  - 2. All wall-mounted items shall be securely fastened to solid backing or blocking.
- C. Center plastic signs on doors, level.
- D. Anchor all components firmly into position for long life under hard use.
- E. Clean and polish.

**END OF SECTION**

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## SECTION 10 26 00

### WALL PROTECTION SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all Wall Protection Systems, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete and proper installation.
- B. Section includes, but is not limited to:
  - 1. Corner Guards
  - 2. Protective Wall Covering
- C. Related Section: Blocking in walls for fasteners

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. Installer qualifications: Engage an installer who has experience in installation of systems similar in complexity to those required for this project.
- B. Manufacturer's qualifications: Not less than 5 years of experience in the production of specified products and a record of successful in-service performance.
- C. Code compliance: Assemblies should conform to all applicable codes including IBC, UBC, SBCCI, BOCA, Life Safety and CA 01350.
- D. Fire performance characteristics: Provide wall protection system components with UL label indicating that they are identical to those tested in accordance with ASTM E84 for Class A/1 characteristics listed below:
  - 1. Flame spread: 25 or less.
  - 2. Smoke developed: 450 or less.
- E. Impact strength: Provide wall protection components that have been tested in accordance with the applicable provisions of ASTM F476.
- F. Chemical and stain resistance: Provide wall protection system components with chemical and stain resistance in accordance with ASTM D543.
- G. Color match: Provide wall protection components that are color matched in accordance with the following: Delta Ecmc of no greater than 1.0 using CIELab color space. (Specifier note: Construction Specialties' colors are matched under cool white fluorescent lighting and computer controlled within manufacturing tolerances. Color may vary if alternate lighting sources are present.)
- H. Single source responsibility: Provide all components of the wall protection system manufactured by the same company to ensure compatibility of color, texture and physical properties.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

#### 1.06 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 Submittal Procedures.
- B. Product data and detailed specifications for each system component and installation accessory required, including installation methods for each type of substrate.
- C. Product test reports from a qualified independent testing laboratory showing compliance of each component with requirements indicated.
- D. Shop drawings showing locations, extent and installation details of wall covering products.
- E. Samples of each product specified for verification purposes: Submit samples as proposed for this work, for verification of color, texture, pattern and thickness.
- F. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship
  - 1. Locate mock-ups on site in locations and size directed by Architect. The mock-up may be part of the work and may be incorporated into the finish when so accepted by the Architect.
  - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
  - 3. Refinish mock-up area as required to produce acceptable work.
  - 4. Retain and maintain mock-ups during construction in undisturbed condition as a standard for judging completed unit of Work.
  - 5. Obtain Architect's acceptance of mock-ups before start of final unit of Work.
  - 6. Mock-up may remain as part of work if acceptable to Architect.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.
- B. Deliver materials to the project site in unopened original factory packaging clearly labeled to show manufacturer.
- C. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 55 degrees F (13 degrees C) or more than 85 degrees F (29 degrees C).
- D. Materials must be stored flat.

#### 1.08 PROJECT CONDITIONS

- A. Materials must be acclimated in an environment of 65-75 degrees F (18-24 degrees C) for at least 24 hours prior to beginning installation.
- B. Installation areas must be enclosed and weatherproofed before installation commences.
- C. Install products after other finishing operations, including painting, have been completed.

#### 1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

#### 1.10 EXTRA MATERIALS

- A. Comply with the requirements of Section 01 77 00 Project Closeout.
- B. Provide 5 percent extra material for each type, color, pattern, and accessory.

1.11 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

**PART 2 - PRODUCTS**

2.01 MATERIALS

- A. Basis of Design Manufacturers: The Corner Guard Store and Construction Specialties, Inc.
- B. Or Architect approved equal.

2.02 PROTECTIVE WALL COVERING

- A. Engineered PETG rigid sheet high-impact Acrovyn 4000 with standard suede texture.
- B. Nominal .040" sheet thickness supplied in 4'x8' and 4'x10' sheet sizes.
- C. Chemical and stain resistant per ASTM D543 standards.
- D. Provide trims as needed for joints/transitions.
- E. Color: As indicated in the Drawings. Provide color-matched caulk.

2.03 CORNER GUARD

- A. Clear Lexan corner guard with fasteners
- B. 90 degree with 2' wings
- C. Refer to Drawings for corner guard height.

2.04 INSTALLATION ACCESSORIES

- A. Fasteners: All fasteners to be non-corrosive and compatible with aluminum retainers. Attachment hardware shall be appropriate for wall construction. All necessary fasteners to be supplied by corner guard manufacturer.
- B. Adhesive: Standard type as recommended by manufacturer to suit products and substrate conditions.

**PART 3 - EXECUTION**

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface preparation: Prior to installation, clean substrate to remove dirt, debris and loose particles. Perform additional preparation procedures as required by manufacturer's instructions.
- B. Protection: Take all necessary steps to prevent damage to material during installation as required in manufacturer's installation instructions.

3.03 INSTALLATION



- A. Install the protective wall covering in strict accordance with the manufacturer's recommendations using approved adhesive where applicable.
- B. Install the corner guards in strict accordance with the manufacturer's recommendations using only approved mounting hardware and locating all components firmly into position, level and plumb.
- C. Temperature at the time of installation must be between 65-75 degrees F (18-24 degrees C) and be maintained for at least 48 hours after the installation to allow for proper adhesive set-up.
- D. Relative humidity shall not exceed 80 percent.
- E. Do not expose wall covering to direct sunlight during or after installation. This will cause the surface temperature to rise, which in turn will cause bubbles and delamination.

3.04 CLEANING AND PROTECTION

- A. General: Immediately upon completion of installation, clean material in accordance with manufacturer's recommended cleaning method.
- B. Remove surplus materials, rubbish and debris resulting from installation as work progresses and upon completion of work.
- C. Protect installed materials to prevent damage by other trades. Use materials that may be easily removed with out leaving residue or permanent stains.

**END OF SECTION**

## SECTION 10 26 41

### **BULLET-RESISTANT FIBERGLASS SHEET**

#### **PART 1 GENERAL**

##### **1.01 GENERAL REQUIREMENTS**

Division 0, Contract Requirements and Division, General Conditions apply to this Section.

##### **1.02 SUMMARY**

###### **A. Section Includes:**

1. Bullet-resistant fiberglass sheet for use in partitions, casework, and assemblies.

###### **B. Related Sections:**

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Section 06 10 00 Framing and Sheathing: Wood framing to receive bullet-resistant sheet.
3. Section 06 40 00 Custom Casework: Casework to receive bullet-resistant sheet.
4. Section 05 41 00 Metal Support Assemblies: Metal framing to receive bullet-resistant sheet.

##### **1.03 REFERENCES**

- A. ASTM International (ASTM) E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- B. Underwriters Laboratories (UL) 752 - Bullet Resisting Equipment.

##### **1.04 SYSTEM DESCRIPTION**

- A. Design Requirements: Provide bullet-resistant sheet of "non-ricochet type" intended to permit capture and retention of attacking projectile, lessening potential of random injury or lateral penetration.

##### **1.05 SUBMITTALS**

###### **A. Submittals for Review:**

1. Product Data: Include product description for bullet-resistant sheet including bullet-resistant ratings.

##### **1.06 WARRANTIES**

- A. Provide manufacturer's 2 year warranty providing coverage against defects in materials and workmanship.

#### **PART 2 PRODUCTS**

##### **2.01 MANUFACTURERS**

- A. Basis of Design: ARMORTEX, 5926 Corridor Parkway, Schertz, Texas, 800-880-8306, [www.armortex.com](http://www.armortex.com).
- B. Or Architect approved equal.

##### **2.02 MATERIALS**

- A. Bullet-Resistant Fiberglass Sheet:
  1. Source: ARMORTEX Opaque Fiberglass.

2. Description:
  - a. Manufactured from multiple layers of woven roving ballistic grade fiberglass cloth impregnated with thermoset polyester resin, compressed into flat rigid sheets.
  - b. Provide controlled internal delaminating to permit capture of penetrating projectile.
3. Ballistic Level: 3, tested to UL 752.
4. Fire rating: 1 hour, tested to ASTM E119.

#### 2.03 ACCESSORIES

- A. Adhesives and Fasteners: Type recommended by bullet-resistant sheet manufacturer for specific application.

### **PART 3 EXECUTION**

#### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Cut panels to fit at perimeter and around penetrations.
- C. Reinforce joints between sheets with minimum 4 inch wide backup layer of bullet-resistant sheet, centered on joint. Bullet-resistance of reinforced joint at least equal to ballistic level of panel.
- D. Fasten or adhere panels to supports in manner to maintain bullet-resistive rating at perimeter, junctures with other materials, and penetrations.

**END OF SECTION**

## SECTION 10 41 00

### EMERGENCY ACCESS CABINETS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all Emergency Access Cabinets (also known as Knox Boxes), as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer.

##### 1.04 QUALITY ASSURANCE

Comply with the Standard requirements established by Manufacturer.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00 Submittal Procedures.

B. Product Data: Provide Manufacturer's descriptive and technical data and installation details.

C. Confirm acceptance of local Fire Marshall.

##### 1.07 DELIVERY, STORAGE AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

A. Comply with the requirements of Section 01 50 00.

B. Comply with Manufacturer's Standard Requirements.

##### 1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with 01 77 00 Project Closeout.

##### 1.10 EXTRA MATERIALS

Not required.

##### 1.11 RECORD DRAWINGS

Not required.

##### 1.12 WARRANTY

Provide Standard Warranty in accordance with Section 01 78 36 Warranties.

#### **PART 2 – PRODUCTS**

##### 2.01 MATERIAL

A. Basis of Design: Knox Company

1. Construction: Heavy-duty, high security
2. Door: 5/8 inch solid steel with gasket
3. Size: 9 1/2 inches high x 9 1/2 inches wide x 5 inches deep
4. Mounting: Recessed
5. Finish: Aluminum Finish

B. Model

1. Model #4400 at Doors
2. Model #3770 at Gates
3. Vehicular Gate Key Control Switch: Know #3502

C. Fastenings: Non-ferrous, type to suit installation conditions

**PART 3 – EXECUTION**

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that specified items may be installed in accordance with the approved design.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

3.02 INSTALLATION

- A. Install lock boxes at locations indicated in accordance with manufacturer's instructions.
- B. Securely fasten in place with sides plumb and level.
- C. Exposed surfaces shall be free from scratches, tool marks, and other damage and defects.

**END OF SECTION**

## SECTION 10 44 00

### FIRE PROTECTION SPECIALTIES

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all Fire Extinguishers and Cabinets, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References as established by Manufacturer

##### 1.04 QUALITY ASSURANCE

A. Conform to NFPA 10 requirements for extinguishers.

B. Provide fire extinguishers, cabinets, and accessories by single manufacturer.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

A. Submit in accordance with Section 01 33 00 Submittal Procedures.

B. Submit the following:

1. Physical dimensions, operational features, color and finish, wall-mounting brackets with mounted measurements, anchorage details, rough-in measurements, location, and details.
2. Manufacturer's installation instructions.
3. Manufacturer's operation and maintenance data.
4. Include test, refill or recharge schedules, procedure, and re-certification requirements.

##### 1.07 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 66 00 Product Storage and Handling Requirements.

B. Do not install extinguishers when ambient temperatures may cause freezing.

##### 1.08 PROJECT CONDITIONS

A. Comply with the requirements of Section 01 50 00.

B. Comply with Manufacturer's Standard Requirements.

##### 1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

##### 1.10 WARRANTY

Provide Standard Warranty in accordance with Section 01 78 36 Warranties.

#### **PART 2 – PRODUCTS**

##### 2.01 MANUFACTURER

Basis of Design: Larsen's Manufacturing Company, 7421 Commerce Lane, N.E. Minneapolis, MN. 55432. Website: [www.larsensmfg.com](http://www.larsensmfg.com). Phone: 1-800-527-7367.

## 2.02 EXTINGUISHERS

Multi-Purpose Chemical Type: Larsen's Steel tank, Model MP 5, with pressure gage, and UL Rating 2A-10B:C or approved equal.

## 2.03 CABINETS

Typical Extinguisher Cabinet:

- A. Provide Larsen's 2409-5R Vertical Duo Door Panel cabinet.
- B. Primer finish.

## 2.04 ACCESSORIES

- A. Mounting Hardware: Appropriate to cabinet - see manufacturer's installation instructions.
- B. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

## 2.05 FABRICATION

- A. Form body of cabinet with tight inside corners and seams.
- B. Pre-drill holes for anchorage.
- C. Form perimeter trim and door stiles by welding, filling, and grinding smooth.
- D. Hinge doors for 180 degree opening.
- E. Glaze doors with resilient channel gasket glazing.

## 2.06 FINISHES

- A. Extinguisher: Red enamel.
- B. Cabinet Trim and Door: Primed to be painted to match adjacent surface.
- C. Cabinet Interior: Enamel white.

# **PART 3 – EXECUTION**

## 3.01 INSPECTION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that rough openings for cabinet are correctly sized and located.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

## 3.02 INSTALLATION

- A. Install cabinets plumb and level in wall openings so that there is 54 inches from finished floor to door handle.
- B. Secure rigidly in place in accordance with manufacturer's instructions.

**END OF SECTION**

## SECTION 10 65 00

### OPERABLE PARTITIONS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

A. This Section includes the following:

1. Manually operated, paired panel operable partitions.

B. Related Sections include the following:

1. Division 03 Sections for concrete tolerances required.
2. Division 05 Sections for primary structural support, including pre-punching of support members by structural steel supplier per operable partition supplier's template.
3. Division 06 Sections for wood framing & supports, and all blocking at head and jambs as required.
4. Division 09 Sections for wall and ceiling framing at head and jambs.

##### 1.03 STANDARDS AND REFERENCES

A. ASTM International

1. ASTM E557 Standard Practice for Architectural Application and Installation of Operable Partitions.
2. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
3. ASTM C1036 - Standard Specification for Flat Glass.
4. ASTM C1048 - Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.
5. ASTM E84 - Surface Burning Characteristics of Building Materials.
6. ASTM E413 - Classification for Rating Sound Insulation

B. International Standards Organization

1. ISO 14021 - Environmental Labels and Declarations - Self-Declared Environmental Claims (Type II Environmental Labeling).
2. ISO 14025:2011-10, Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures.
3. ISO 14040:2009-11, Environmental Management - Life Cycle Assessment - Principles and Framework.
4. ISO 14044:2006-10, Environmental Management - Life Cycle Assessment - Requirements and Guidelines.
5. ISO 21930 – Sustainability in Buildings and Civil Engineering Works — Core Rules for Environmental Product Declarations of Construction Products and Services.

C. Other Standards

1. ADA – Americans with Disabilities Act.



2. ANSI Z97.1 - Safety Glazing Materials Used in Buildings.
3. CPSC 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
4. NEMA LD3 - High Pressure Decorative Laminates.

#### 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified in writing by the operable partition manufacturer, as qualified to install the manufacturer's partition systems for work similar in material, design, and extent to that indicated for this Project.
- B. Acoustical Performance: Test operable partitions in an independent acoustical laboratory in accordance with ASTM E90 test procedure and classified in accordance with ASTM E413 to attain no less than the STC rating specified. Provide a complete and unedited written test report by the testing laboratory upon request.
- C. Preparation of the opening shall conform to the criteria set forth per ASTM E557 *Standard Practice for Architectural Application and Installation of Operable Partitions*.
- D. The operable wall must be manufactured by a certified ISO-9001-2015 company or an equivalent quality control system.

#### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

#### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: Material descriptions, construction details, finishes, installation details, and operating instructions for each type of operable partition, component, and accessory specified.
- C. Shop Drawings: Show location and extent of operable partitions. Include plans, elevations, sections, details, attachments to other construction, and accessories. Indicate dimensions, weights, conditions at openings, and at storage areas, and required installation, storage, and operating clearances. Indicate location and installation requirements for hardware and track, including floor tolerances required and direction of travel. Indicate blocking to be provided by others.
- D. Setting Drawings: Show imbedded items and cutouts required in other work, including support beam punching template.
- E. Samples: Color samples demonstrating full range of finishes available by architect. Verification samples will be available in same thickness and material indicated for the work.
- F. Reports: Provide a complete and unedited written sound test report indicating test specimen matches product as submitted.
- G. Buy American: Folding door to be manufactured in the United States in compliance with applicable U.S. Federal Trade Commission (FTC) and U.S. Customs Service and Border Protections regulations and be labeled "Made in America".

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Clearly mark packages and panels with numbering systems used on Shop Drawings. Do not use permanent markings on panels.
- B. Protect panels during delivery, storage, and handling to comply with manufacturer's direction and as required to prevent damage.

1.08 WARRANTY

- A. Provide written warranty by manufacturer of operable partitions agreeing to repair or replace any components with manufacturing defects.
- B. Warranty period: Two (2) years.
- C. Suspension System Warranty:
  - 1. Training Room A / B: Five (5) years.
  - 2. Training Room B / C: Five (5) years.

**PART 2 – PRODUCTS**

2.01 MANUFACTURERS, PRODUCTS, AND OPERATION

- A. Basis of Design Manufacturer: Subject to compliance with requirements, provide product by the following:
  - 1. Modernfold, Inc. Partition Specialties Inc. Contact: Robert Kaminski M: 310 420-3874
- B. Doors to be manufactured in the U.S.A.
- C. Products: Subject to compliance with the requirements, provide the following product:
  - 1. Training Room A / B: Acousti-Seal Legacy - Paired Panel: Manually operated paired panel operable partition.
  - 2. Training Room B / C: Acousti-Seal Legacy - Paired Panel: Manually operated paired panel operable partition.

2.02 OPERATION

- A. Training Room A / B: Acousti-Seal Legacy - Paired Panel: Series of paired flat panels hinged together in pairs, manually operated, top supported with operable floor seals.
- B. Training Room B / C: Acousti-Seal Legacy - Paired Panel: Series of paired flat panels hinged together in pairs, manually operated, top supported with operable floor seals.
- C. Final Closure:
  - 1. Training Room A / B: Horizontally expanding panel edge with removable crank
  - 2. Training Room B / C: Horizontally expanding panel edge with removable crank

2.03 PANEL CONSTRUCTION

- A. Training Room A / B: Nominal 3-inch (76mm) thick panels in manufacturer's standard 48-inch (1220mm) widths. All panel horizontal and vertical framing members fabricated from minimum 16-gage formed steel with overlapped and welded corners for rigidity. Top channel is reinforced to support suspension system components. Frame is designed so that full vertical edges of panels are of formed steel and provide concealed protection of the edges of the panel skin.
- B. Training Room B / C: Nominal 3-inch (76mm) thick panels in manufacturer's standard 48-inch (1220mm) widths. All panel horizontal and vertical framing members fabricated from minimum 16-gage formed steel with overlapped and welded corners for rigidity. Top channel is reinforced to support suspension system components. Frame is designed so that full vertical edges of panels are of formed steel and provide concealed protection of the edges of the panel skin.
- C. Panel skin shall be:

1. Training Room A / B: Roll-formed steel wrapping around panel edge. Panel skins shall be lock formed and welded directly to the frame for unitized construction. Acoustical ratings of panels with this construction minimum:

- a. 50 STC

2. Training Room B / C: Roll-formed steel wrapping around panel edge. Panel skins shall be lock formed and welded directly to the frame for unitized construction. Acoustical ratings of panels with this construction minimum:

- a. 50 STC

D. Hinges for Panels, Closure Panels, Pass Doors, and Pocket Doors shall be:

1. Training Room A / B: SOSS invisible laminated hinge with antifriction segments mounted between each heat treated link. Welded internal hinge bracket shall support the hinge and allow for adjustment of hinge plates. Concealed hinges or hinges mounted into panel edge or vertical astragal are not acceptable. Exposed hinge barrels are not acceptable.
2. Training Room B / C: SOSS invisible laminated hinge with antifriction segments mounted between each heat treated link. Welded internal hinge bracket shall support the hinge and allow for adjustment of hinge plates. Concealed hinges or hinges mounted into panel edge or vertical astragal are not acceptable. Exposed hinge barrels are not acceptable.

E. Panel Trim: No vertical trim required or allowed on edges of panels; minimal groove appearance at panel joints.

F. Panel Weights:

1. Training Room A / B: 50 STC - 8 lbs./square foot
2. Training Room B / C: 50 STC - 8 lbs./square foot

2.04 PANEL FINISH

A. Panel finish shall be:

1. Training Room A / B: Reinforced vinyl with woven backing weighing not less than 21 ounces (595 grams) per lineal yard.
2. Training Room B / C: Reinforced vinyl with woven backing weighing not less than 21 ounces (595 grams) per lineal yard.

B. Panel Trim: Exposed panel trim of one consistent color:

1. Training Room A / B: Natural Choice
2. Training Room B / C: To Be Advised

2.05 SOUND SEALS

- A. Vertical Interlocking Sound Seals between panels: Roll-formed steel astragals, with reversible tongue and groove configuration in each panel edge for universal panel operation. Rigid plastic or aluminum astragals or astragals in only one panel edge are not acceptable.
- B. Horizontal Top Seals: Continuous contact extruded vinyl bulb shape with pairs of non-contacting vinyl fingers to prevent distortion without the need for mechanically operated parts.
- C. Horizontal bottom floor seals shall be:
  1. Training Room A / B: Modernfold IA2 Bottom seal. Automatic operable seals providing nominal 2-inch (51mm) operating clearance with an operating range of +0.50-inch (13mm) to -1.50-inch (38mm) which automatically drop as panels are positioned, without the need for tools or cranks.

2. Training Room B / C: Modernfold IA2 Bottom seal. Automatic operable seals providing nominal 2-inch (51mm) operating clearance with an operating range of +0.50-inch (13mm) to -1.50-inch (38mm) which automatically drop as panels are positioned, without the need for tools or cranks.

## 2.06 SUSPENSION SYSTEM

### A. Training Room A / B: #17 Suspension System

1. Suspension Tracks: Minimum 11-gauge, 0.12-inch (3.04mm) roll-formed steel track, suitable for either direct mounting to a wood header or supported by adjustable steel hanger brackets, supporting the load-bearing surface of the track, connected to structural support by pairs of 0.38-inch (10mm) diameter threaded rods. Aluminum track is not acceptable.
  - a. Exposed track soffit: Steel, integral to track, and pre-painted off-white.
2. Carriers: One all-steel trolley with steel tired ball bearing wheels per panel (except hinged panels). Non-steel tires are not acceptable.

### B. Training Room B / C: #17 Suspension System

1. Suspension Tracks: Minimum 11-gauge, 0.12-inch (3.04mm) roll-formed steel track, suitable for either direct mounting to a wood header or supported by adjustable steel hanger brackets, supporting the load-bearing surface of the track, connected to structural support by pairs of 0.38-inch (10mm) diameter threaded rods. Aluminum track is not acceptable.
  - a. Exposed track soffit: Steel, integral to track, and pre-painted off-white.
2. Carriers: One all-steel trolley with steel tired ball bearing wheels per panel (except hinged panels). Non-steel tires are not acceptable.

## PART 3 – EXECUTION

### 3.01 INSTALLATION

- A. General: Comply with ASTM E557, operable partition manufacturer's written installation instructions, Drawings and approved Shop Drawings.
- B. Install operable partitions and accessories after other finishing operations, including painting have been completed.
- C. Match operable partitions by installing panels from marked packages in numbered sequence indicated on Shop Drawings.
- D. Broken, cracked, chipped, deformed or unmatched panels are not acceptable.

### 3.02 CLEANING AND PROTECTION

- A. Clean partition surfaces upon completing installation of operable partitions to remove dust, dirt, adhesives, and other foreign materials according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions in a manner acceptable to the manufacturer and Installer that ensure operable partitions are without damage or deterioration at time of Substantial Completion.

### 3.03 ADJUSTING

- A. Adjust operable partitions to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Lubricate hardware and other moving parts.

3.04 EXAMINATION

- A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable partitions. Proceed with installation only after unsatisfactory conditions have been corrected.

3.05 DEMONSTRATION

- A. Demonstrate proper operation and maintenance procedures to Owner's representative.
- B. Provide Operation and Maintenance Manual to Owner's representative.

**END OF SECTION**

NOT FOR BID

## SECTION 11 31 13

### APPLIANCES

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all Appliances, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.

##### 1.03 STANDARDS AND REFERENCES

- A. ANSI A117-1 – Guidelines for Accessible and Useable Buildings and Facilities.
- B. EPA – Energy Star Appliances.
- C. Public Law 101-336 – Americans with Disabilities Act.

##### 1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with referenced standards and the Americans with Disabilities Act as applicable for fixtures for the disabled.
- B. Energy Rating: Provide appliances with the EPA Energy Star label where applicable.
- C. Coordinate rough-in requirements with adjacent construction. Coordinate components and fittings to ensure compatible parts are installed.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Model number and selected options for each appliance.
  - 2. Preparation instructions and recommendations.
  - 3. Storage and handling requirements and recommendations.
  - 4. Installation methods.
  - 5. List of maintenance parts.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Store products in manufacturer's unopened packaging until ready for installation.

##### 1.08 PROJECT CONDITIONS

Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

##### 1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

##### 1.10 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. As indicated in the Drawings.
- B. Or Owner approved equal.

## **PART 3 – EXECUTION**

### **3.01 INSPECTION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Do not begin installation until substrates have been properly prepared. Coordinate rough-in with appliance sized and utility requirements.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Do not proceed until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of conditions.

### **3.02 PREPARATION**

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### **3.03 INSTALLATION**

Assemble appliances and trim and install in accordance with manufacturer's instructions and the following:

1. Securely mount to substrate
2. Install appliances plumb and level and in proper relationship to adjacent construction.
3. Connect appliances to building utility, supply and waste systems as applicable.
4. Test for proper orientation and drainage. Adjust until proper operation is achieved.

### **3.04 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

### **3.05 APPLIANCE DATA SHEETS**

Refer to the manufacturer's data sheets as attached to this Section for required features and additional requirements.

**END OF SECTION**

## SECTION 11 52 13

### PROJECTION SCREENS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK

- A. Projection Screen.
- B. All accessories and hardware for a complete and proper installation.

##### 1.03 RELATED WORK

- A. Documents affecting this Work include: General Conditions, Special Conditions, and Sections of Division 1 of these Specifications.
- B. Gypsum Systems.
- C. Finish Carpentry.

##### 1.04 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00.

##### 1.05 SUBMITTALS

Provide in accordance with Section 01 33 00.

##### 1.06 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.07 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

##### 1.08 WARRANTY

Provide manufacturer's standard warranty in accordance with Section 01 78 36 Warranties.

#### **PART 2 – PRODUCTS**

##### 2.01 MANUFACTURERS

Basis of Design: Da-lite by Milestone: Model C manual projection screen. Legrand AV Division Headquarters, 6436 City West Parkway, Eden Prairie, MN 55344. Phone (866) 977-3901. Website: [www.milestone.com/products/da-lite](http://www.milestone.com/products/da-lite).

##### 2.02 FABRICATION

- A. 6'-0" x 8'-0" projection screen recess ceiling mounted.
- B. Screen Fabric: Flame retardant, mildew resistant fiberglass; glass beaded picture surface with black masking borders. Fabric to be permanently attached to roller.
- C. Case: 21-gauge steel, powder coated case with black enamel finish and end caps.



## **PART 3 – EXECUTION**

### **3.01    PREPARATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify adequate support of wood encasement by finish carpenter.
- C. Correct conditions detrimental to timely and proper complete of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

### **3.02    INSTALLATION**

- A. Coordinate with other Sections to provide necessary support during the proper sequence of Work.
- B. Install in accordance with manufacturer's instructions.
- C. Install case and screen level and plumb.
- D. Verify smooth operation of all components.

### **3.03    CLEANING**

- A. Leave work clean and operating smoothly.
- B. Wipe clean case after installation.
- C. Clean screen of any marring during installation.

**END OF SECTION**

## SECTION 12 20 00

### WINDOW TREATMENTS

#### **PART 1 GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SECTION INCLUDES

- A. Manually operated, roll-up fabric interior window shades including mounting and operating hardware.

##### 1.03 RELATED SECTIONS

- A. Section 06 10 00 – Rough Carpentry: Blocking for support of window shade hardware.
- B. Section 07 90 00 – Joint Protection: Sealants for perimeter of shade system.
- C. Section 09 29 00 – Gypsum Board Assemblies: Suspended gypsum board ceilings to contain recessed window shade pockets.
- D. Section 09 51 00 – Acoustical Tile Ceilings: Suspended acoustical panel ceilings to contain recessed window shade pockets.

##### 1.04 REFERENCES

- A. NFPA 701-99 - Fire Tests for Flame-Resistant Textiles and Films.
- B. GREENGUARD Environmental Institute Gold.
- C. ANSI/WCMA A100.1-2018

##### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of twenty years' experience in manufacturing products comparable to those specified in this section.
- B. NFPA Flame-Test: Passes NFPA 701. Materials tested shall be identical to products proposed for use.

##### 1.06 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.07 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Product Data: Manufacturer's data sheets on each product specified, including:
  - 1. Preparation instructions and recommendations.
  - 2. Installation and maintenance instructions.
  - 3. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
  - 4. Storage and handling requirements and recommendations.
  - 5. Mounting details and installation methods.
- C. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings, field verified window dimensions, quantities, type of shade, controls, fabric, and color, and include opening sizes and key to typical mounting details.

- D. Selection Samples: For each finish product specified, two complete sets of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two complete sets of shade components, unassembled, demonstrating compliance with specified requirements. Shade fabric sample and aluminum finish sample as selected, representing actual product, color, and patterns. Mark face of material to indicate interior faces.
- F. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.
- G. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver window shades until building is enclosed and construction within spaces where shades will be installed is substantially complete.
- B. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.
- C. Label containers and shades according to Window Shade Schedule.
- D. Store products in manufacturer's unopened packaging until ready for installation.

1.09 SEQUENCING

- A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.
- B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.010 PROJECT CONDITIONS

- A. Install roller shades after finish work and ambient temperature, humidity and ventilation conditions are maintained at levels recommended for project upon completion.

1.011 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

1.012 WARRANTY

- A. Provide manufacturer's standard warranty in accordance with Section 01 78 36 Warranties.
- B. Hardware and Shade Fabric: Draper's standard twenty-five year limited warranty.

## **PART 2 PRODUCTS**

2.01 MANUFACTURERS

- A. Basis of Design Manufacturer: Draper, Inc., which is located at: 411 S. Pearl P. O. Box 425; Spiceland, IN 47385-0425. ASD. Toll Free Tel: 800-238-7999; Tel: 765-987-7999; Fax: 866-637-5611; Web: www.draperinc.com.
- B. Or Architect approved equal.

2.02 MANUALLY OPERATED WINDOW SHADES

- A. Manually Operated Window Shades with Independent Control: Manually operated, vertical roll-up, fabric window shade with components necessary for complete installation; Clutch-operated FlexShade as manufactured by Draper, Inc.

1. Operation: Bead chain and clutch operating mechanism allowing shade to stop when chain is released. Designed never to need adjustment or lubrication. Provide limit stops to prevent shade from being raised or lowered too far.
  - a. Clutch mechanism: Fabricated from high carbon steel and molded fiberglass reinforced polyester or injected molded nylon. Minimum 20 lb. lifting capacity. White or Black color as selected by Architect.
  - b. Bead chain loop: Stainless steel bead chain hanging at side of window.
  - c. Idler Assembly: Provide roller idler assembly of molded nylon with adjustable or spring-loaded length idler pin to facilitate easy installation, and removal of shade for service.
  - d. Bead Chain Hold Down: P-Clip (standard).
2. Single Roller Configuration:
  - a. Mounting:
    - 1) Endcaps and fascia.
  - b. Endcaps: Stamped steel with universal design suitable for mounting to ceiling, wall, and jamb. Provide size compatible with roller size.
    - 1) Endcap covers: To match fascia or headbox color.
  - c. Fascia: L shaped aluminum extrusion to conceal shade roller and hardware.
    - 1) Attachment: Snaps onto endcaps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. No notching is required.
    - 2) Shape: Square Fascia Panel.
    - 3) Finish: Standard powder coat as selected by Architect.
3. Shade slat:
  - a. Closed pocket elliptical slat: 1 inch (25 mm) aluminum elliptical slat inside of a 1-5/8 inch (41 mm) pocket with heat sealed ends.
4. Light Gap Reduction Channels.
  - a. Aluminum L Angle – 3/4 inch (19 mm) by 1 inch (25 mm).
  - b. Aluminum L Angle -1 inch (25 mm) by 2-3/4 inches (70mm).
  - c. Vinyl L Angle-1-1/2 inches (38 mm) by 3/4 inch (19 mm).
  - d. U Channel -1 inch (25 mm) by 2-1/2 inches (64 mm).
  - e. H Channel – 1 inch (25 mm) by 5 inches (127 mm).

## 2.03 FABRIC

### A. Light-Filtering Fabrics

1. SheerWeave® Infinity2, 3%: sustainable window treatment fabric eco-friendly basketweave. Core yarn and coating are PVC-free, lead-free and 100 percent recyclable. Fire classification: ASTM E-84 (Class I), NFPA 701-2004 TM#1 (small scale), NFPA 101 (Class A Rating) and CAN/ULC-S 109-03 Large, GREENGUARD®, GREENGUARD Gold®. Average 3 percent open. Average Fabric Thickness: .031 inch (.79 mm) Average Fabric Weight: 13.69 ounces per square yard.

### B. Color and pattern: As indicated in Drawings.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### **3.02 PREPARATION**

- A. Coordinate requirements for blocking, construction of shade pockets, and structural supports to ensure adequate means for installation of window shades.
- B. Coordinate installation of recessed shade pockets with construction of suspended acoustical panel ceilings specified in Section 09 51 00.

### **3.03 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install roller shades level, plumb, square, and true. Allow proper clearances for window operation hardware.
- C. Install the following items to conceal roller and operating mechanism. Do not use exposed fasteners.
  - 1. Fascias.
  - 2. Closure panels.
  - 3. Endcaps.
- D. Install side channels, and sill channel with sealant specified in Section 07 90 00 - Joint Sealers to eliminate light leaks at perimeter of shade system.
- E. Position shades level, plumb, and at proper height relative to adjacent construction. Secure with fasteners recommended by manufacturer.

### **3.04 TESTING AND DEMONSTRATION**

- A. Test window shades to verify that operating mechanism and other operating components are functional. Correct deficiencies.
  - 1. Chain and clutch.
- B. Demonstrate operation of shades to Owner's designated representatives.

### **3.05 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

### **3.06 SCHEDULES**

- A. Refer to Drawings for shade types and locations.

**END OF SECTION**

## SECTION 12 48 13

### ENTRANCE MATS

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. Supply and install all Entrance floor mats and frames, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation
- B. Section includes, but is not limited to: Entrance floor mats and frames, including fibered roll good entrance systems

##### 1.03 STANDARDS AND REFERENCES

- A. ASTM International
  - 1. ASTM D 2859 Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
  - 2. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- B. Other referenced documents
  - 1. NFPA: National Fire Protection Association
  - 2. Consumer Products Safety Commission (CPSC) FF 1-70: Pill Test
  - 3. Department of Commerce (DOC) FF 1-70: Pill Test
  - 4. AAATCC: American Association of Textile Chemists and Colorists
  - 5. LEED-NC v. 3

##### 1.04 QUALITY ASSURANCE

- A. Installer: Installer shall be highly experienced in performing work of this section, having previous done fiber roll goods installation work similar to that required for this project.
- B. Testing Agency: Agency(ies) shall be independent and qualified to perform the specified product tests.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: For specified products, submit latest edition of product supplier's technical specifications data (available from [www.matsinc.com](http://www.matsinc.com)).
- C. Test and Evaluation Reports:
  - 1. Product test reports: As required by Conditions of the Contract and Division 1 Regulatory Requirements Section, submit test certificates from an independent test laboratory showing compliance with specified performance characteristics and physical properties.

2. Compatibility and adhesion test reports: Submit test reports confirming adhesive's effectiveness with the product(s) specified.
- D. Shop Drawings: Submit shop drawings showing layout, profiles, and product components.
- E. Samples: Submit selection and verification samples showing the required finishes, colors, designs, and textures for flooring, as well as samples of adhesives and applicable accessories such as nosing, frames, etc.
- F. Preinstallation Meetings: Meet to confirm project requirements, substrate conditions, manufacturer's installation instructions and warranty requirements in compliance with Division 1 requirements.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the requirements of Sections 01 66 00 Product Storage and Handling Requirements.
- B. Delivery and Acceptance Requirements: Comply with the product supplier's ordering and lead time requirements to avoid construction delays, and to allow material to acclimatize as required in the specified product's installation instructions. Accept delivery of materials only if they are in unopened, undamaged packaging that bears the name and brand of the manufacturer/product supplier, project identification, and shipping and handling instructions.
- C. Storage and Handling Requirements: Store material -- including any adhesive and accessories -- in the original packaging (as delivered) in areas that are enclosed and weather tight with the permanent HVAC system set at a temperature of between 65°F and 80°F for a minimum of 48 hours prior to commencement of installation. In addition, comply with storage and handling requirements listed on product packaging, and described in the latest edition of the product's installation instructions (available from [www.matsinc.com](http://www.matsinc.com)).

#### 1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Sections 01 50 00.
- B. Coordination: Install entrance matting after finishing operations, including painting and ceiling operations, have been completed.
- C. Ambient site Conditions: The permanent HVAC system shall be operational and set at a temperature of between 65°F and 80°F for a minimum of 48 hours prior to commencement of installation, during the time of installation, and for 48 hours after installation has been completed. Thereafter, minimum temperature shall be 55°F.

#### 1.09 OPERATION AND MAINTENANCE DATA

- A. Provide in accordance with Section 01 77 00 Project Closeout.
- B. Manufacturer Instructions: For specified products, submit latest editions of product supplier's installation and cleaning & maintenance instructions (available from [www.matsinc.com](http://www.matsinc.com)).

#### 1.10 WARRANTY

- A. Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.
- B. Warranty documentation: For specified products and accessories, submit product supplier's warranty documents (available from [www.matsinc.com](http://www.matsinc.com)).

### **PART 2 - PRODUCTS**

#### 2.01 MANUFACTURERS

- A. Supplier: Mats Inc., 37 Shuman Avenue, Stoughton, MA 02072; telephone: 1.800.MATS.INC (1.800.628.7462); fax: 1.781.344.1537; email: [info@matsinc.com](mailto:info@matsinc.com); website: [www.matsinc.com](http://www.matsinc.com).

- B. Product: 3M™ Nomad™ Z-Web Medium Traffic Scraper Matting 6250  
Construction: Nonwoven continuous vinyl filaments with vinyl foam backing  
Width: 3'  
Length: approximately 60'  
Thickness: 7/16"  
Weight: 126.82 ounces/square yard  
Colors: Grey
- C. Performance: Physical properties of the entrance matting shall conform to the following minimums:
- |                          |  |
|--------------------------|--|
| <u>Safety</u>            |  |
| Surface flammability     | ASTM D2859: Pass (equal to CPSC FF 1-70) |
| Flammability             | NFPA 253: 0.81 watts/cm <sup>2</sup>     |
| <u>Performance</u>       |  |
| Fungal growth            | ASTM G21: inhibiting to fungal growth    |
| Chemical resistance      | AATCC 134: resistant to most chemicals   |
| Electrostatic propensity | AATCC 134: 1.6 kV                        |

## 2.02 ACCESSORY PRODUCTS

- A. Matting Tape: 3M Stay-in-Place Matting Tape 130  
B. Other: 3M Matting Adhesive

## **PART 3 – EXECUTION**

### 3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verification of Conditions: Subfloors shall be clean and dry. Inspect all substrates and subfloors for proper tolerances.
- C. Notify the Construction Manager and Architect in writing of any conditions detrimental to the proper and timely completion of the installation.
- D. Correct conditions detrimental to timely and proper complete of the Work.
- E. Do not proceed until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of conditions.

### 3.02 SURFACE PREPARATION

- A. Preinstallation Measurements: Verify actual measurement by field measuring before any onsite cutting, if applicable. To avoid construction delays, coordinate field measurements based upon construction progress.
- B. Concrete subfloors: Where concrete subfloors are present, all work required to put the concrete subfloor in acceptable condition shall be the responsibility of the general contractor. See the state requirements for the project location.

### 3.03 INSTALLATION

- A. Follow Division 01 relevant guidelines, and the latest edition of the manufacturer's installation instructions (available from [www.matsinc.com](http://www.matsinc.com))
- B. Interface with Other Work: If transitions are required to and/or from the specified entrance matting, contact Mats Inc. for suitable transition material.



- C. Sizes: Where not indicated otherwise, provide single unit for each mat installation, but do not exceed manufacturer's maximum size recommendation for units intended for removal and cleaning. Where possible, verify sizes by field measurement before shop fabrication.
- D. Accessory selection: Where indicated for recessed or wall-to-wall applications provide aluminum framework as recommended by manufacturer. Where indicated for surface-mounted applications, provide tapered vinyl moldings with flanges sewn to back of mat on all four sides with mitered corners.

#### 3.04 CLEANING

- A. General: Clean up job site, including sweeping or dust mopping the floor to remove all dirt or grit, and put all waste in general contractor's dumpster. Follow overall cleaning guidelines described in Division 01.
- B. Initial Maintenance: Conduct a full initial maintenance following the latest edition of the manufacturer's maintenance instructions (available from [www.matsinc.com](http://www.matsinc.com)). Instruct owner's cleaning staff in proper maintenance procedures.

**END OF SECTION**

## SECTION 13 46 00

### BALLISTIC BARRIER TRANSACTION SYSTEM

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this section.

##### 1.02 DESIGN

Though the design, manufacturing technique and material application, this assembly shall provide single or multiple transaction positions utilizing the "natural voice" baffle configuration. This design shall employ offset vertical standing vision panels and 5" baffles to complete the "natural voice" design as well as to protect against angled ballistic penetrations. Components must be manufactured in strict accordance with the specifications, design and details. All vision panels and baffles shall be cut to size with all exposed edges polished. Necessary holes shall be pre drilled and tapped where required. Stainless Steel assembly screws and acrylic spacers shall be provided. Clear anodized angles and channels shall be provided in field lengths. Anchor screws shall be provided by the installer. No field alterations to the construction of the units fabricated under the acceptable standards shall be allowed unless approved by the manufacturer and the architect. Standard manufacturing tolerances shall be +/- 1/16".

##### 1.03 SUBMITTALS

Products shall be submitted in accordance with Division 1 and the SPECIAL CONTRACT REQUIREMENTS if any. Submit for approval prior to fabrication: Catalog cuts, shop drawings, specifications, frame profiles, size, type and spacing of frame anchors, reinforcement size and locations, details of joints and connections, welding details and printed data in sufficient detail to indicate compliance with the contract documents. The provider of this window must be ISO 9001:2008 Certified by an accredited registrar and provide proof of such. Provide manufacturer's instructions for installation and cleaning.

##### 1.04 WARRANTY

All materials and workmanship shall be warranted against defects for a period of one (1) year from date of receipt at job site.

#### **PART 2 - PRODUCTS**

##### 2.01 MANUFACTURER

Basis of Design: Armortex® 5926 Corridor Pkwy, Schertz, Texas. [www.armortex.com](http://www.armortex.com) Phone: 210-661-8306, 800-880-8306, Fax: 210-661-8308.

##### 2.02 FRAMING

Extruded aluminum angle 1 1/4" x 1 1/4" x 1/8" at Jams, 2" x 1" x 1/8" angle at Head, 1 1/4" x 1 9/16" U-Shaped channel at sill. Acrylic 1" spacer and stainless steel security screws at baffles.

##### 2.03 FINISH

Anodized Finish Class I Clear

##### 2.04 GLAZING PANELS-BAFFLES

The glazing must be UL Listed Level 3, Multi-ply Polycarbonate or Acrylic Polycarbonate Composite with all exposed edges polished clear.

2.05 VOICE PORT

Windows are to have natural voice ports for sound transmission. Voice ports must be made of the same glazing material and must overlap the gap in the glazing as indicated by manufacturer. Voice port sizes are specified in the Drawings.

2.06 COUNTER, DEAL TRAY AND PACKAGE EXCHANGE

Provide counter top materials as indicated in the Drawings, lined with UL-752 ballistic fiberglass, the same level of protection as the glazing. Counter to have built-in stainless steel non-ricochet deal tray and transparent package exchange.

**PART 3 - EXECUTION**

3.01 INSTALLATION

Set frames and glaze in accordance with manufacturer's instructions. Proper anchoring device shall be determined by the material to be anchored. Repair damaged units as directed (if approved by the manufacturer and the architect) prior to completion and the acceptance of the project. Or replace with new units as directed by the architect.

3.02 PROTECTION

Touch up scratches or disfigurement caused by shipping and handling of the product. Properly store all the frames, glazing material etc. in a dry location and covered to protect from damage before and after installation.

3.03 CLEANING

Upon completion, clean exposed surfaces of frames and glazing products thoroughly in accordance with manufacturer's instructions. Remove mastic smears and other unsightly marks.

**END OF SECTION**

## SECTION 22 00 00

### GENERAL PLUMBING REQUIREMENTS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SCOPE

- A. Basic plumbing requirements specifically applicable to Division 22 Sections.
- B. Work includes but is not necessarily limited to the following:
  - 1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:
    - i. Plumbing systems and equipment

##### 1.03 DRAWINGS AND SPECIFICATIONS

- A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a first class manner.
- B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.
- C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the Owner has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the Owner's Representative.
- D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.
- E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

##### 1.04 UTILITIES

- A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given, and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

##### 1.05 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS:

- A. Meet requirements of all state codes having jurisdiction.
- B. State of California Code of Regulations:
  - 1. Title 8, Industrial Relations

2. Title 19, State Fire Marshal Regulations
3. Current California Building Code (CBC), Title 24, Part 2
4. Current California Electrical Code, Title 24, Part 3
5. Current California Mechanical Code, Title 24, Part 4
6. Current California Plumbing Code, Title 24, Part 5
7. Current California Fire Code, Title 24, Part 9
8. Current California Standards Code, Title 24, Part 12
9. Title 24, Energy Conservation Standards
10. California Green Building Standard Code, Title 24, Part 11

C. Additional Referenced Standards:

1. ASME American Society of Mechanical Engineers
2. ASTM American Society for Testing and Materials
3. NEMA National Electrical Manufacturer's Association
4. NFPA National Fire Protection Association Standards
5. PDI Plumbing and Drainage Institute
6. UL Underwriters Laboratories

D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the Owner's Representative.

E. Obtain permits, and request inspections from authority having jurisdiction.

1.06 PROJECT AND SITE CONDITIONS

- A. The arrangement of and connection to equipment shown on the drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.
- B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.
- C. Examine site related work and surfaces before starting work of any Section.
- D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.
- E. Prepare shop drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the Owner's Representative before proceeding.
- F. Plumbing Contractor shall be fully responsible to survey all underground utilities prior to installation of any utilities.
- G. Beginning work of any Section constitutes acceptance of conditions.
- H. All connections to site piping shall be done by the plumbing contractor.

- I. All work shall be performed in a clean and workmanlike manner. Care shall be exercised to minimize any inconvenience or disturbance to other areas of the building which are to remain in operation. Isolate work areas by means to keep dust and dirt within the construction area.
- J. All piping into stem walls and footings shall be double half lap wrapped with 1/8" thick "Armaflex" insulation. The contractor shall also provide blocked out areas in stem wall and footing. All piping shall avoid the lower 8" of the footing.
- K. All existing piping damaged during construction shall be repaired with materials to match existing by the contractor.

#### 1.07 COOPERATION WITH WORK UNDER OTHER DIVISIONS

- A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
- B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.
- C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.
- D. Make such progress in the Work to not delay work of other trades.
- E. Coordinate with electrical contractor prior to ordering equipment for available voltages at all equipment locations.
- F. Mechanical Work shall have precedence over the other in the following sequence:
  - 1. Soil and waste piping
  - 2. Hydronic piping
  - 3. Ductwork
  - 4. Fire sprinkler piping
  - 5. Domestic water piping

#### 1.08 DISCREPANCIES

- A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify the Owner's Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.
- B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.
- C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without Owner Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

#### 1.09 CHANGES

- A. The Contractor shall be responsible to make and obtain approval from the Owner's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

#### 1.10 SUBMITTALS

- A. Refer to Division 01 for additional requirements.

- B. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
- C. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
- D. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- E. Note that prior to acceptance of submittals for review, a submittal schedule shall be submitted to the owner's representative.
- F. Submit all division 22 shop drawings and product data grouped and referenced by the specification technical section numbers in one complete submittal package. Individual or partial submittals are not acceptable and will be returned without review.
- G. Shop Drawings:
  - 1. Provide all shop drawings in latest version of Revit/AutoCAD format and PDF format.
  - 2. Drawings shall be a 30 inches by 42 inches in size with a minimum scale of 1/4-inch per foot, except as specified otherwise.
  - 3. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
  - 4. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
  - 5. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.
  - 6. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner's Representative bearing the Owner's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the Owner's Representative without additional compensation.
- H. Whenever more than one manufacturer's product is specified, the first named product is the basis of design used in the Work and the use of alternate-named manufacturer's products or substitutes may require modifications in that design.
- I. Proposed Products List: Include Products as required by the individual section in this Division.
- J. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner's Representative bearing the Owner's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the Owner's Representative without additional compensation.
- K. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
- L. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the Owner Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Owner

Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.

- M. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
- N. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

#### 1.11 PROJECT RECORD DOCUMENTS

- A. Refer to Division 01 for additional requirements.
  - 1. All changes, deviations and information recorded on the "Project Record Drawings" set during Construction shall be redrafted onto the latest version of AutoCAD or Revit, where applicable.
  - 2. Submit completed shop drawings to the Owner prior to completion in AutoCAD format. Contractor hand marked or drafted redlined "Project Record Drawings" will not be accepted.

#### 1.12 PRODUCT ALTERNATIVES OR SUBSTITUTIONS

- A. Refer to General Conditions and Division 01 for additional requirements.

#### 1.13 OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

#### 1.14 MANUFACTURER'S RECOMMENDATIONS

- A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

#### 1.15 DELIVERY AND STORAGE

- A. Refer to Division 01 for additional requirements.
- B. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

#### 1.16 GUARANTEE

- A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.



- B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner for their service agency as directed.

## **PART 2 - PRODUCTS**

Not Applicable.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the Owner's Representative.

### **3.02 WORK RESPONSIBILITIES**

- A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.
- B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.
- C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.
- D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.
- F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the Owner immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the Owner.
- G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Owner and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.
- H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.
- I. Replace or repair, without additional compensation, any work, which, in the opinion of the Owner, does not comply with these requirements.

### **3.03 PAINTING**

- A. Refer to Division 09 Painting for additional requirements.

B. Factory Applied:

1. Plumbing equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
2. Refer to individual sections of this Division for more stringent requirements.

C. Field Applied:

1. Paint all plumbing equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.
2. Paint all exposed plumbing piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness.
3. Paint shall be a high performance polyurethane enamel coating system.
4. Acceptable primer manufacturers include:
  - i. Ameron Amershield VOC, Tnemec's Series 1075 (1074) Endura-Shield, semi-gloss (gloss) sheen or equal.
5. Acceptable paint manufacturers include:
  - i. Ameron, Tnemec or engineer approved equal.

**END OF SECTION**

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## SECTION 22 05 00

### COMMON WORK RESULTS FOR PLUMBING

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Transition fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Concrete bases.
11. Supports and anchorages.

##### 1.02 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  1. ABS: Acrylonitrile-butadiene-styrene plastic.
  2. CPVC: Chlorinated polyvinyl chloride plastic.
  3. PE: Polyethylene plastic.
  4. PVC: Polyvinyl chloride plastic.

##### 1.03 SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All

**exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

C. Welding certificates.

1. Welding certificates.
2. Product Information for approval before purchase
3. Operation and Maintenance Manuals

#### 1.04 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### 1.06 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

## **PART 2 - PRODUCTS**

### **2.01 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. All plumbing pipe, tube and fittings shall be manufactured exclusively in the United States.

### **2.02 JOINING MATERIALS**

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals:
  - 1. Conform to AWS A5.8.
  - 2. Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 3. Use 15% silver brazing filler metal without flux.
- F. Welding Filler Metals: Comply with AWS D10.12. for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
  - 1. ABS Piping: ASTM D 2235.
  - 2. CPVC Piping: ASTM F 493.
  - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - 4. PVC to ABS Piping Transition: ASTM D 3138.

### **2.03 DIELECTRIC FITTINGS**

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

### **2.04 MECHANICAL SLEEVE SEALS**

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
  - i. Advance Products & Systems, Inc.
  - ii. Calpico, Inc.
  - iii. Metraflex Co.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.05 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.06 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  1. Finish: Polished chrome-plated.

## 2.07 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  2. Design Mix: 5000-psi, 28-day compressive strength.
  3. Packaging: Premixed and factory packaged.

## **PART 3 - EXECUTION**

### **3.01 PLUMBING DEMOLITION**

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 3. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 4. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### **3.02 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.



1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.03 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
  2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  5. PVC Nonpressure Piping: Join according to ASTM D 2855.
  6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
  2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.04 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.05 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

### 3.06 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES.

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.08 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

**END OF SECTION**

## SECTION 22 05 17

### SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  1. "No Exception Taken".
  2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product.

#### PART 2 - PRODUCTS

##### 2.01 SLEEVES

- A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded water stop collar.
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

##### 2.02 STACK-SLEEVE FITTINGS

- A. Manufactured, cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
  1. Underdeck Clamp: Clamping ring with setscrews.

##### 2.03 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Thunderline Modular Seals; Link-Seal

2. Metraflex Co.
3. Advance Products & Systems, Inc.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Stainless steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
6. Link-Seal shall be the basis of design.

2.04 GROUT

- A. Description: Non-shrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

## **PART 3 - EXECUTION**

3.01 SLEEVE INSTALLATION

- A. Sleeves are not required for core-drilled holes, except where spill control is required
- B. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- C. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
  1. Sleeves are not required for core-drilled holes
- D. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

2. Cut sleeves to length for mounting flush with both surfaces.
    - i. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
  3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- E. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
  2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- F. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

### 3.02 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
  3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
  4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

### 3.03 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.04 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

- C. Secure nailing flanges to concrete forms.
- D. Use grout to seal the space around outside of sleeve-seal fittings.

### 3.05 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:

- 1. Exterior Concrete Walls above Grade:

- i. Piping Smaller Than NPS 6: Galvanized Steel pipe sleeves.
- ii. Piping NPS 6 and Larger: Galvanized Steel pipe sleeves .

- 2. Exterior Concrete Walls below Grade:

- i. Piping Smaller Than NPS 6: Galvanized Steel pipe sleeves with sleeve-seal system.
  - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- ii. Piping NPS 6 and Larger: Galvanized Steel pipe sleeves with sleeve-seal system.
  - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

- 3. Concrete Slabs-on-Grade:

- i. Piping Smaller Than NPS 6: Galvanized steel pipe sleeves with sleeve-seal system.
  - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- ii. Piping NPS 6 and Larger: Galvanized steel pipe sleeves with sleeve-seal system.
  - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

- 4. Concrete Slabs above Grade:

- i. Piping Smaller Than NPS 6: Steel pipe sleeves.
- ii. Piping NPS 6 and Larger: Steel pipe sleeves.

- 5. Interior Partitions:

- i. Piping Smaller Than NPS 6: Steel pipe sleeves.
- ii. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

**END OF SECTION**

## SECTION 22 05 18

### ESCUTCHEONS FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

##### 1.03 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product.

#### PART 2 - PRODUCTS

##### 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. BrassCraft Manufacturing Co.; a Masco company.
  - 2. Keeney Manufacturing Company (The).
  - 3. Mid-America Fittings, Inc.

##### 2.02 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.



- F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

## 2.03 FLOOR PLATES

- A. Split Floor Plates: Cast brass with concealed hinge.

## **PART 3 - EXECUTION**

### 3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping and Relocated Existing Piping:
    - i. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
    - ii. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
    - iii. Insulated Piping: One-piece steel with polished, chrome-plated finish.
    - iv. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
    - v. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
    - vi. Insulated Piping: One-piece stamped steel with polished, chrome-plated finish.
    - vii. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
    - viii. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
    - ix. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
    - x. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel with polished, chrome-plated finish.
    - xi. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
    - xii. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
    - xiii. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
    - xiv. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel with polished, chrome-plated finish.
    - xv. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
    - xvi. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
    - xvii. Bare Piping in Unfinished Service Spaces: One-piece stamped steel with polished, chrome-plated finish.

- xviii. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
- xix. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated finish.
- xx. Bare Piping in Equipment Rooms: One-piece stamped steel with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:

- i. Chrome-Plated Piping: Split-casting, stamped steel with concealed hinge with polished, chrome-plated finish.
- ii. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish
- iii. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- iv. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- v. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- vi. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

- 1. New Piping and Relocated Existing Piping: One-piece, floor plate.
- 2. Existing Piping: Split floor plate.

3.02 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

**END OF SECTION**

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## SECTION 22 05 23

### GENERAL DUTY VALVES FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Bronze lift check valves.
4. Bronze swing check valves.
5. Bronze gate valves.

##### 1.03 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  1. "No Exception Taken".
  2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of valve.
  1. Certification that products comply with NSF 61 and NSF 372.
- C. The Manufacturer, Contractor or Supplier Shall Include A Written Statement That The Submitted Equipment, Hardware Or Accessory Complies With The Requirement Of This Particular Specification Section.
  1. The Manufacturer Shall Resubmit This Specification Section Showing Compliance with Each Respective Paragraphs and Specified Items And Features.
  2. All Exceptions Shall Be Clearly Identified by Referencing Respective Paragraph And Other Requirements Along With Proposed Alternative.

3. Individual or Partial Submittals Are Not Acceptable and Will Be Returned Without Review.

#### 1.05 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  2. ASME B31.1 for power piping valves.
  3. ASME B31.9 for building services piping valves
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  1. Protect internal parts against rust and corrosion.
  2. Protect threads, flange faces, and soldered ends.
  3. Protect threads, flange faces, grooves, and weld ends.
  4. Set ball valves open to minimize exposure of functional surfaces.
  5. Set check valves in either closed or open position.
  6. Set gate valves closed to prevent rattling.
  7. Set butterfly valves closed or slightly open.
- B. Use the following precautions during storage:
  1. Maintain valve end protection.
  2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

### **PART 2 - PRODUCTS**

#### 2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  1. ASME B1.20.1 for threads for threaded end valves.
  2. ASME B16.1 for flanges on iron valves.
  3. ASME B16.5 for flanges on steel valves.
  4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  5. ASME B16.18 for solder-joint connections.
  6. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

- D. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. RS Valves in Insulated Piping: With 2-inch stem extensions.
- H. Valve Sizes: Same as upstream piping unless otherwise indicated.
- I. Valve Bypass and Drain Connections: MSS SP-45.
- J. Valve Actuator Types:
  - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
  - 2. Handlever: For quarter-turn valves smaller than NPS 6.
- K. Valves in Insulated Piping:
  - 1. Include 2-inch stem extensions.
  - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
  - 3. Memory stops that are fully adjustable after insulation is applied.

## 2.02 BRASS BALL VALVES

### A. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. NIBCO INC.
  - iii. Red White Valve Corp.
- 2. Description:
  - i. Standard: MSS SP-110 or MSS SP-145.
  - ii. CWP Rating: 600 psig.
  - iii. Body Design: Two piece.
  - iv. Body Material: Forged brass.
  - v. Ends: Threaded and soldered.
  - vi. Seats: PTFE.
  - vii. Stem: Brass.
  - viii. Ball: Chrome-plated brass.
  - ix. Port: Full.

### B. Brass Ball Valves, Three-Piece with Full Port and Brass Trim:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Jomar Valve.

- ii. KITZ Corporation.
- iii. WATTS.

2. Description:

- i. Standard: MSS SP-110.
- ii. CWP Rating: 600 psig.
- iii. Body Design: Three piece.
- iv. Body Material: Forged brass.
- v. Ends: Threaded and soldered.
- vi. Seats: PTFE.
- vii. Stem: Brass.
- viii. Ball: Chrome-plated brass.
- ix. Port: Full.

2.03 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. Milwaukee Valve Company.
  - iii. NIBCO INC.

2. Description:

- i. Standard: MSS SP-110 or MSS-145.
- ii. CWP Rating: 600 psig.
- iii. Body Design: Two piece.
- iv. Body Material: Bronze.
- v. Ends: Threaded and soldered.
- vi. Seats: PTFE.
- vii. Stem: Bronze or brass.
- viii. Ball: Chrome-plated brass.
- ix. Port: Full.

B. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Press Ends:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. NIBCO INC.
  - iii. WATTS.

2. Description:

- i. Standard: MSS SP-110 or MSS-145.
- ii. CWP Rating: Minimum 200 psig.
- iii. Body Design: Two piece.
- iv. Body Material: Bronze.
- v. Ends: Press.
- vi. Press Ends Connections Rating: Minimum 200 psig.
- vii. Seats: PTFE or RTPFE.
- viii. Stem: Bronze or brass.
- ix. Ball: Chrome-plated brass.
- x. Port: Full.
- xi. O-Ring Seal: EPDM or Buna-N.

C. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. NIBCO INC.
  - iii. WATTS.
- 2. Description:
  - i. Standard: MSS SP-110 or MSS-145.
  - ii. CWP Rating: 600 psig.
  - iii. Body Design: Two piece.
  - iv. Body Material: Bronze.
  - v. Ends: Threaded or soldered.
  - vi. Seats: PTFE.
  - vii. Stem: Stainless steel.
  - viii. Ball: Stainless steel, vented.
  - ix. Port: Full.

D. Bronze Ball Valves, Three-Piece with Full Port and Bronze or Brass Trim:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. NIBCO INC.
  - iii. WATTS.
- 2. Description:
  - i. Standard: MSS SP-110.
  - ii. CWP Rating: 600 psig.



- iii. Body Design: Three piece.
- iv. Body Material: Bronze.
- v. Ends: Threaded.
- vi. Seats: PTFE.
- vii. Stem: Bronze or brass.
- viii. Ball: Chrome-plated brass.
- ix. Port: Full.

## 2.04 BRONZE SWING CHECK VALVES

### A. Bronze Swing Check Valves with Bronze Disc, Class 125:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. NIBCO INC.
  - iii. Stockham; Crane Energy Flow Solutions.
- 2. Description:
  - i. Standard: MSS SP-80, Type 3.
  - ii. CWP Rating: 200 psig.
  - iii. Body Design: Horizontal flow.
  - iv. Body Material: ASTM B 62, bronze.
  - v. Ends: Threaded or soldered. See valve schedule articles.
  - vi. Disc: Bronze.

### B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. Crane; Crane Energy Flow Solutions.
  - iii. NIBCO INC.
- 2. Description:
  - i. Standard: MSS SP-80, Type 4.
  - ii. CWP Rating: 200 psig.
  - iii. Body Design: Horizontal flow.
  - iv. Body Material: ASTM B 62, bronze.
  - v. Ends: Threaded or soldered. See valve schedule articles.
  - vi. Disc: PTFE.

### C. Bronze Swing Check Valves with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- i. Apollo Flow Controls; Conbraco Industries, Inc.
- ii. Crane; Crane Energy Flow Solutions.
- iii. NIBCO INC.

2. Description:

- i. Standard: MSS SP-80, Type 3.
- ii. CWP Rating: 300 psig.
- iii. Body Design: Horizontal flow.
- iv. Body Material: ASTM B 62, bronze.
- v. Ends: Threaded or soldered. See valve schedule articles.
- vi. Disc: Bronze.

D. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- i. Crane; Crane Energy Flow Solutions.
- ii. Milwaukee Valve Company.
- iii. NIBCO INC.

2. Description:

- i. Standard: MSS SP-80, Type 4.
- ii. CWP Rating: 300 psig.
- iii. Body Design: Horizontal flow.
- iv. Body Material: ASTM B 62, bronze.
- v. Ends: Threaded or soldered. See valve schedule articles.
- vi. Disc: PTFE.

2.05 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- i. Apollo Flow Controls; Conbraco Industries, Inc.
- ii. KITZ Corporation.
- iii. NIBCO INC.

2. Description:

- i. Standard: MSS SP-80, Type 1.
- ii. CWP Rating: 200 psig.
- iii. Body Material: Bronze with integral seat and screw-in bonnet.

- iv. Ends: Threaded or solder joint.
- v. Stem: Bronze.
- vi. Disc: Solid wedge; bronze.
- vii. Packing: Asbestos free.
- viii. Handwheel: Malleable iron, bronze, or aluminum.

B. Bronze Gate Valves, RS, Class 125:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. KITZ Corporation.
  - iii. NIBCO INC.
- 2. Description:
  - i. Standard: MSS SP-80, Type 2.
  - ii. CWP Rating: 200 psig.
  - iii. Body Material: Bronze with integral seat and screw-in bonnet.
  - iv. Ends: Threaded or solder joint.
  - v. Stem: Bronze.
  - vi. Disc: Solid wedge, bronze.
  - vii. Packing: Asbestos free.
  - viii. Handwheel: Malleable iron, bronze, or aluminum.

C. Bronze Gate Valves, NRS, Class 150:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. NIBCO INC.
  - iii. WATTS.
- 2. Description:
  - i. Standard: MSS SP-80, Type 1.
  - ii. CWP Rating: 300 psig.
  - iii. Body Material: Bronze with integral seat and union-ring bonnet.
  - iv. Ends: Threaded.
  - v. Stem: Bronze.
  - vi. Disc: Solid wedge; bronze.
  - vii. Packing: Asbestos free.
  - viii. Handwheel: Malleable iron, bronze, or aluminum.

D. Bronze Gate Valves, RS, Class 150:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. NIBCO INC.
  - iii. WATTS.
2. Description:
  - i. Standard: MSS SP-80, Type 2.
  - ii. CWP Rating: 300 psig.
  - iii. Body Material: Bronze with integral seat and union-ring bonnet.
  - iv. Ends: Threaded.
  - v. Stem: Bronze.
  - vi. Disc: Solid wedge; bronze.
  - vii. Packing: Asbestos free.
  - viii. Handwheel: Malleable iron, bronze, or aluminum.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

#### **3.02 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- F. Check Valves: Install check valves for proper direction of flow.
  1. Swing Check Valves: In horizontal position with hinge pin level.
  2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

### 3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If ball valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
  1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
  2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  4. For Grooved-End Copper Tubing and Steel Piping: Grooved.
- C. If check valve applications are not indicated, use the following:
  1. Pump-Discharge Check Valves:
    - i. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
    - ii. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat or resilient-seat check valves.
    - iii. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- D. Use gate valves for shutoff service only.

### 3.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  1. Brass ball valve, one piece. Provide with threaded or solder-joint ends.
  2. Bronze ball valve, one piece with bronze or stainless-steel trim. Provide with threaded or solder-joint ends.
  3. Brass ball valves, two-piece with full-port and brass or stainless-steel trim. Provide with threaded or solder-joint ends.
  4. Bronze ball valves, two-piece with full-port and bronze, brass or stainless-steel trim. Provide with threaded or solder-joint ends.
  5. Brass ball valves, three-piece with full port and brass or stainless-steel trim.
  6. Bronze ball valves, three-piece with full port and bronze, brass or stainless-steel trim.
  7. Bronze ball valves, two-piece with regular port and bronze or stainless-steel trim.
  8. Bronze swing check valves with bronze disc, Class 125 or Class 150, with soldered or threaded end connections.
  9. Bronze gate valves, NRS, RS, Class 125 or Class 150 with soldered or threaded ends.
- B. Pipe NPS 2-1/2 and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Steel ball valves, Class 150 with full-port.
3. Iron ball valves, Class 150.
4. Iron swing check valves with metal seats, Class 125 or Class 250, with threaded or flanged end connections.
5. Iron swing check valves with closure control lever and spring or weight, Class 125, with threaded or flanged end connections.
6. Iron, grooved-end swing check valves, 300 CWP.
7. Iron, center-guided check valves with compact wafer, Class 125, Class 150, Class 250 or Class 300.
8. Iron, center-guided check valves with globe, metal, resilient seat, Class 125, Class 150, Class 250 or Class 300, with threaded or flanged end connections.
9. Iron, dual-plate check valves with metal, resilient seat, Class 125, Class 150, Class 250 or Class 300, with threaded or flanged end connections.
10. Iron, single-plate check valves with resilient seat, Class 125 or Class 250, with threaded or flanged end connections.
11. Iron gate valves, NRS, OS&Y, Class 125 or Class 250 with flanged ends.
12. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze, ductile-iron or stainless-steel disc.
13. Ductile-Iron, Grooved-End Butterfly Valves: 175 or 300 CWP.

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## SECTION 22 05 29

### HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal hanger-shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe-positioning systems.
8. Equipment supports.

###### B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- B. Product Data: For each type of product indicated including component cut-sheets and pre-approved details.

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.



- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
    - 1. Trapeze pipe hangers.
    - 2. Metal framing systems.
    - 3. Pipe stands.
    - 4. Equipment supports.
  - D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
    - 1. Detail fabrication and assembly of trapeze hangers.
    - 2. Include design calculations for designing trapeze hangers.
- 1.04 INFORMATIONAL SUBMITTALS
- A. Welding certificates.
- 1.05 QUALITY ASSURANCE
- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
  - B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

## **PART 2 - PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

### **2.02 METAL PIPE HANGERS AND SUPPORTS**

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
  - 3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel stainless steel.

2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. B-line, an Eaton business.
  - ii. Flex-Strut Inc.
  - iii. Unistrut; Part of Atkore International.
2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel stainless-steel, Type 304 stainless-steel, Type 316 extruded-aluminum Insert material channel with inturred lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel stainless steel.
8. Metallic Coating: No coating Plain Pregalvanized G90 Electroplated zinc Hot-dip galvanized Gold (yellow zinc dichromate) galvanized.
9. Paint Coating: Green epoxy, acrylic, or urethane.
10. Plastic Coating: PVC.
11. Combination Coating.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. Anvil International.
  - ii. PHD Manufacturing, Inc.
  - iii. Sioux Chief Manufacturing Company, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel stainless-steel channel with inturned lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel stainless steel.
8. Metallic Coating: No coating Plain Pregalvanized G90 Hot-dip galvanized
9. Paint Coating: Green epoxy, acrylic, or urethane.
10. Plastic Coating: PVC.

#### 2.05 THERMAL HANGER-SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. National Pipe Hanger Corporation.
  2. Pipe Shields Inc.
  3. Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig ASTM C552, Type II cellular glass with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

#### 2.06 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - i. Hilti, Inc.
    - ii. ITW Ramset/Red Head; Illinois Tool Works, Inc.
    - iii. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. B-line, an Eaton business.
  - ii. Hilti, Inc.
  - iii. ITW Ramset/Red Head; Illinois Tool Works, Inc.
2. Indoor Applications: Zinc-coated or stainless steel.
3. Outdoor Applications: Stainless steel.

## 2.07 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two galvanized stainless-steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: Adjustable horizontal, galvanized stainless-steel pipe support channels.
5. Pipe Supports: Roller Strut clamps Clevis hanger Swivel hanger.
6. Hardware: Galvanized Stainless steel.
7. Accessories: Protection pads.
8. Height: 12 inches above roof.

D. High-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.
3. Vertical Members: Two galvanized stainless-steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: One adjustable-height, galvanized- or stainless-steel, pipe-support slotted channel or plate.
5. Pipe Supports: Roller Clevis hanger Swivel hanger.
6. Hardware: Galvanized Stainless steel.

7. Accessories: Protection pads, 1/2-inch, continuous-thread, galvanized-steel rod, 1/2-inch, continuous-thread, stainless-steel rod.
8. Height: 36 inches above roof.

E. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber molded polypropylene.
3. Vertical Members: Two or more, galvanized stainless-steel channels.
4. Horizontal Members: One or more, adjustable-height, galvanized stainless-steel pipe support.
5. Pipe Supports: Roller Strut clamps Clevis hanger Swivel hanger.
6. Hardware: Galvanized Stainless steel.
7. Accessories: Protection pads, 1/2-inch, continuous-thread rod.
8. Height: 36 inches above roof.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.08 PIPE-POSITIONING SYSTEMS

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.09 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.10 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
  1. Properties: Non-staining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi, 28-day compressive strength.

## **PART 3 - EXECUTION**

3.01 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum

static design load used for strength determination shall be weight of supported components plus 200 lb.

### 3.02 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Pipe Stand Installation:
  - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- H. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- N. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:

1. Attach clamps and spacers to piping.
  - i. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
  - ii. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
  - iii. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - i. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - i. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - i. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - ii. NPS 4: 12 inches long and 0.06 inch thick.
  - iii. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
  - iv. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
  - v. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.05 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.06 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099113 "Exterior Painting." Section 099123 "Interior Painting." Section 099600 "High-Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

### 3.07 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal hanger-shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.



4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
  7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
  11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
  18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
  20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
  21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - i. Light (MSS Type 31): 750 lb.
    - ii. Medium (MSS Type 32): 1500 lb.
    - iii. Heavy (MSS Type 33): 3000 lb.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - i. Horizontal (MSS Type 54): Mounted horizontally.
    - ii. Vertical (MSS Type 55): Mounted vertically.
    - iii. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

**END OF SECTION**

## SECTION 22 05 53

### IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Stencils.
  - 5. Valve tags.
  - 6. Warning tags.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product indicated.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve numbering scheme.
- F. Valve Schedules: For each piping system to include in maintenance manuals.

##### 1.04 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

##### 1.05 GENERAL

- A. Manufacturers:
  - 1. Craftmark Identification Systems
  - 2. Seton Identification Products

3. Setmark

**PART 2 - PRODUCTS**

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Brady Corporation.
  - ii. Marking Services, Inc.
  - iii. Seton Identification Products.
2. Material and Thickness: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Red.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Brady Corporation.
  - ii. Marking Services, Inc.
  - iii. Seton Identification Products.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Red.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.02 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Brady Corporation.
  - 2. Marking Services, Inc.
  - 3. Seton Identification Products.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick and having predrilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.03 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  - 2. Brady Corporation.
  - 3. Seton Identification Products.
- B. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.
- C. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

## 2.04 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Brimar Industries, Inc.
  - ii. Marking Services, Inc.
  - iii. Seton Identification Products.
2. Lettering Size: Size letters according to ASME A13.1 for piping.
3. Stencil Material: Brass.
4. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

## 2.05 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.

B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain or S-hook.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.06 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.

- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
  2. Fasteners: Brass grommet and wire.
  3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  4. Color: Safety yellow background with black lettering.

### **PART 3 - EXECUTION**

#### **3.01 PREPARATION**

- A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

#### **3.02 GENERAL INSTALLATION REQUIREMENTS**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

#### **3.03 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

#### **3.04 PIPE LABEL INSTALLATION**

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
1. Identification Paint: Use for contrasting background.
  2. Stencil Paint: Use for pipe marking.
- C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.



- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Color Schedule:
1. Low-Pressure Compressed Air Piping:
    - i. Background: Safety blue.
    - ii. Letter Colors: White.
  2. High-Pressure Compressed Air Piping:
    - i. Background: Safety blue.
    - ii. Letter Colors: White.
  3. Domestic Water Piping
    - i. Background: Safety green.
    - ii. Letter Colors: White.
  4. Sanitary Waste and Storm Drainage Piping:
    - i. Background Color: Safety green.
    - ii. Letter Color: White.

### 3.05 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
    - i. Cold Water: 2 inches, round.
    - ii. Hot Water: 2 inches, round.
    - iii. Low-Pressure Compressed Air: 2 inches, round.
    - iv. High-Pressure Compressed Air: 2 inches, round.
  2. Valve-Tag Colors:
    - i. Cold Water: Natural.
    - ii. Hot Water: Natural.
    - iii. Low-Pressure Compressed Air: Natural.
    - iv. High-Pressure Compressed Air: Natural.
  3. Letter Colors:
    - i. Cold Water: Black White.
    - ii. Hot Water: Black.
    - iii. Low-Pressure Compressed Air: Black.
    - iv. High-Pressure Compressed Air: Black.

3.06 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

**END OF SECTION**

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## SECTION 22 07 19

### PLUMBING PIPING INSULATION

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Domestic recirculating hot-water piping.
  - 4. Domestic chilled-water piping for drinking fountains.
  - 5. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
  - 1. Section 220716 "Plumbing Equipment Insulation."

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- C. Sustainable Design Submittals:
  - 1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
  - 2. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.

6. Detail application of field-applied jackets.
  7. Detail application at linkages of control devices.
- E. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
  2. Jacket Materials for Pipe: 12 inches long by NPS 2.
  3. Sheet Jacket Materials: 12 inches square.
  4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  1. Piping Mockups:
    - i. One 10-foot section of NPS 2 straight pipe.
    - ii. One each of a 90-degree threaded, welded, and flanged elbow.
    - iii. One each of a threaded, welded, and flanged tee fitting.
    - iv. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
    - v. Four support hangers including hanger shield and insert.
    - vi. One threaded strainer and one flanged strainer with removable portion of insulation.
    - vii. One threaded reducer and one welded reducer.
    - viii. One pressure temperature tap.

- ix. One mechanical coupling.
- 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
- 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
- 4. Obtain Architect's approval of mockups before starting insulation application.
- 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
- 7. Demolish and remove mockups when directed.
- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.07 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.08 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## **PART 2 - PRODUCTS**

### 2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Aeroflex USA, Inc.
    - ii. Armacell LLC.
    - iii. K-Flex USA.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. CertainTeed Corporation.
    - ii. Johns Manville; a Berkshire Hathaway company.
    - iii. Owens Corning.
- H. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Johns Manville; a Berkshire Hathaway company.
    - ii. Manson Insulation Inc.
    - iii. Owens Corning.
  - 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Phenolic:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - i. Resolco Inc.
  - 2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type III, Grade 1.
  - 3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type II, Grade 1.
  - 4. Factory fabricate shapes according to ASTM C450 and ASTM C585.
  - 5. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.

## 2.02 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- i. Ramco Insulation, Inc.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - i. Ramco Insulation, Inc.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - i. Ramco Insulation, Inc.

## 2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Aeroflex USA, Inc.
    - ii. Armacell LLC.
    - iii. K-Flex USA.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Childers Brand; H. B. Fuller Construction Products.
    - ii. Foster Brand; H. B. Fuller Construction Products.
    - iii. Eagle Bridges - Marathon Industries.
    - iv.
- D. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Childers Brand; H. B. Fuller Construction Products.
    - ii. Foster Brand; H. B. Fuller Construction Products.
- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Childers Brand; H. B. Fuller Construction Products.
    - ii. Foster Brand; H. B. Fuller Construction Products.
    - iii. Mon-Eco Industries, Inc.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.



1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Johns Manville; a Berkshire Hathaway company.
  - ii. P.I.C. Plastics, Inc.
  - iii. Dow Corning Corporation.

## 2.04 MASTICS AND COATINGS

### A. Materials shall be compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
2. Mastics shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- 3.

### B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Childers Brand; H. B. Fuller Construction Products.
  - ii. Foster Brand; H. B. Fuller Construction Products.
  - iii. Knauf Insulation.
2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

### C. Vapor-Retarder Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Childers Brand; H. B. Fuller Construction Products.
  - ii. Foster Brand; H. B. Fuller Construction Products.
  - iii. Eagle Bridges - Marathon Industries.
2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: 0 to 180 deg F.
4. Color: White.

### D. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Childers Brand; H. B. Fuller Construction Products.
  - ii. Foster Brand; H. B. Fuller Construction Products.

- iii. Eagle Bridges - Marathon Industries.
- 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
- 3. Service Temperature Range: Minus 50 to plus 220 deg F.
- 4. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Childers Brand; H. B. Fuller Construction Products.
    - ii. Foster Brand; H. B. Fuller Construction Products.
    - iii. Knauf Insulation.
    - iv. Vimasco Corporation.
  - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Color: White.

## 2.05 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
  - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Childers Brand; H. B. Fuller Construction Products.
    - ii. Foster Brand; H. B. Fuller Construction Products.
    - iii. Vimasco Corporation.
  - 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
  - 4. Service Temperature Range: 0 to plus 180 deg F.
  - 5. Color: White.

## 2.06 SEALANTS

- A. Joint Sealants for Phenolic Products:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Childers Brand; H. B. Fuller Construction Products.
    - ii. Foster Brand; H. B. Fuller Construction Products.
    - iii. Pittsburgh Corning Corporation.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Permanently flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 100 to plus 300 deg F.
  - 5. Color: White or gray.

6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

8.

B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Childers Brand; H. B. Fuller Construction Products.
  - ii. Foster Brand; H. B. Fuller Construction Products.
  - iii. Eagle Bridges - Marathon Industries.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - i. Childers Brand; H. B. Fuller Construction Products.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.07 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.08 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - i. Childers Brand; H. B. Fuller Construction Products.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Foster Brand; H. B. Fuller Construction Products.
  - ii. Vimasco Corporation.

#### 2.09 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - i. Alpha Associates, Inc.

#### 2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Johns Manville; a Berkshire Hathaway company.
  - ii. P.I.C. Plastics, Inc.
  - iii. Proto Corporation.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
  - i. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. ITW Insulation Systems; Illinois Tool Works, Inc.
  - ii. RPR Products, Inc.
2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - i. Factory cut and rolled to size.
  - ii. Finish and thickness are indicated in field-applied jacket schedules.
  - iii. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  - iv. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  - v. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.

- 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
  - 3) Tee covers.
  - 4) Flange and union covers.
  - 5) End caps.
  - 6) Beveled collars.
  - 7) Valve covers.
  - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Pittsburgh Corning Corporation.
    - ii. Polyguard Products, Inc.

## 2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Avery Dennison Corporation, Specialty Tapes Division.
    - ii. Ideal Tape Co., Inc., an American Biltrite Company.
    - iii. Knauf Insulation.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Avery Dennison Corporation, Specialty Tapes Division.
    - ii. Ideal Tape Co., Inc., an American Biltrite Company.
    - iii. Knauf Insulation.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - i. Ideal Tape Co., Inc., an American Biltrite Company.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Avery Dennison Corporation, Specialty Tapes Division.
    - ii. Ideal Tape Co., Inc., an American Biltrite Company.
    - iii. Knauf Insulation.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.

## 2.12 SECUREMENTS

### A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. ITW Insulation Systems; Illinois Tool Works, Inc.
  - ii. RPR Products, Inc.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

### B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

### C. Wire: 0.080-inch nickel-copper alloy 0.062-inch soft-annealed, stainless steel 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - i. C & F Wire.

## 2.13 PROTECTIVE SHIELDING GUARDS

### A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. McGuire Manufacturing. (With integral insulation).
  - ii. Or equal products.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

### B. Protective Shielding Piping Enclosures: (Subject to architect's approval).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Truebro.
  - ii. Zurn Industries, LLC.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

## **PART 3 - EXECUTION**

### 3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches 4 inches o.c.
    - i. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.



- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Cleanouts.

### 3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.07 INSTALLATION OF MINERAL-FIBER INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

### 3.08 INSTALLATION OF PHENOLIC INSULATION

#### A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.09 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.10 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - i. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- E. All adhesive shall be as recommended by cellular glass manufacturer and with a VOC content of 80 g/L or less.
- F. Per ASHRAE 189.1, All adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

### 3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.

2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.13 INDOOR PIPING INSULATION SCHEDULE

#### A. Domestic Hot and Recirculated Hot Water:

1. NPS 3/4 and Smaller: Insulation shall be one of the following:
  - i. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
2. NPS 1 and Larger: Insulation shall be one of the following:
  - i. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

#### B. Domestic Chilled Water (Potable):

1. All Pipe Sizes: Insulation shall be one of the following:
  - i. Flexible Elastomeric: 1 inch thick.
  - ii. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
  - iii. Phenolic: 1 inch thick.

#### C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be one of the following:
  - i. Flexible Elastomeric: 1 inch thick.
  - ii. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

#### D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:
  - i. Flexible Elastomeric: 1 inch thick.
  - ii. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

#### E. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be one of the following:
  - i. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

#### F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
  - i. Flexible Elastomeric: 1 inch thick.
  - ii. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

### 3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed: None.
- C. Piping, Exposed: PVC, Color-Coded by system, 30 mils thick for all indoor applications.

### 3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed: None.

C. Piping, Exposed: Aluminum, Stucco Embossed, 0.024 inch thick.

**END OF SECTION**

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## SECTION 22 10 23

### FACILITY NATURAL-GAS PIPING

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Manual gas shutoff valves.
5. Motorized gas valves.
6. Earthquake valves.
7. Dielectric fittings.

##### 1.03 DEFINITIONS

- A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  1. "No Exception Taken".
  2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of the following:
  1. Piping specialties.
  2. Corrugated, stainless-steel tubing with associated components.
  3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  4. Pressure regulators. Indicate pressure ratings and capacities.
  5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings bypass fittings and meter bars meter bars supports.

6. Dielectric fittings.
  - C. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
    1. Shop Drawing Scale: 1/4 inch per foot.
    2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.
  - D. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
    1. Detail fabrication and assembly of seismic restraints.
    2. Design Calculations: Calculate requirements for selecting seismic restraints.
- 1.05 INFORMATIONAL SUBMITTALS
- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
  - B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
  - C. Qualification Data: For qualified professional engineer.
  - D. Welding certificates.
  - E. Field quality-control reports.
- 1.06 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For motorized gas valves pressure regulators and service meters to include in emergency, operation, and maintenance manuals.
- 1.07 QUALITY ASSURANCE
- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
  - C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 1.08 DELIVERY, STORAGE, AND HANDLING
- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
  - B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
  - C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.
  - D. Protect stored PE pipes and valves from direct sunlight.
- 1.09 PROJECT CONDITIONS
- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
1. Notify Architect Construction Manager Owner no fewer than two Insert number days in advance of proposed interruption of natural-gas service.
  2. Do not proceed with interruption of natural-gas service without Architect's Construction Manager's Owner's written permission.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

**PART 2 - PRODUCTS**

2.01 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
  2. Service Regulators: 100 psig minimum unless otherwise indicated.
  3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig.
- C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.
- D. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.
- E. Natural-Gas System Pressures within Buildings: Three pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressures of more than 0.5 psig but not more than 2 psig, and is reduced again to pressures of 0.5 psig or less.
- F. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.02 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
  3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    - i. Material Group: 1.1.

- ii. End Connections: Threaded or butt welding to match pipe.
  - iii. Lapped Face: Not permitted underground.
  - iv. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
  - v. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
- 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
  - i. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- 6. Mechanical Couplings:
  - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) GE Oil & Gas.
    - 2) Smith-Blair, Inc.
  - ii. Stainless-steel Steel flanges and tube with epoxy finish.
  - iii. Buna-nitrile seals.
  - iv. Stainless-steel Steel bolts, washers, and nuts.
  - v. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
  - vi. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. FlashShield Products; Gastite, a division of Titeflex Corp.
    - ii. TracPipe CounterStrike; Omega Flex, Inc.
    - iii. Tru-Flex Metal Hose Corp.
  - 2. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
  - 3. Coating: PE with flame retardant.
    - i. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      - 1) Flame-Spread Index: 25 or less.
      - 2) Smoke-Developed Index: 50 or less.
  - 4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
  - 5. Striker Plates: Steel, designed to protect tubing from penetrations.
  - 6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.

7. Operating-Pressure Rating: 5 psig.

C. PE Pipe: ASTM D2513, SDR 11.

1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
  3. Anode less Service-Line Risers: Factory fabricated and leak tested.
    - i. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
    - ii. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    - iii. Aboveground Portion: PE transition fitting.
    - iv. Outlet shall be threaded or flanged or suitable for welded connection.
    - v. Tracer wire connection.
    - vi. Ultraviolet shield.
    - vii. Stake supports with factory finish to match steel pipe casing or carrier pipe.
  4. Transition Service-Line Risers: Factory fabricated and leak tested.
    - i. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    - ii. Outlet shall be threaded or flanged or suitable for welded connection.
    - iii. Bridging sleeve over mechanical coupling.
    - iv. Factory-connected anode.
    - v. Tracer wire connection.
    - vi. Ultraviolet shield.
    - vii. Stake supports with factory finish to match steel pipe casing or carrier pipe.
  5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Lyall, R. W. & Company, Inc.
      - 2) Mueller Co.
      - 3) Perfection Corporation.
    - ii. PE body with molded-in, stainless-steel support ring.
    - iii. Buna-nitrile seals.
    - iv. Acetal collets.
    - v. Electro-zinc-plated steel stiffener.
  6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Lyall, R. W. & Company, Inc.
- 2) Mueller Co.
- 3) Perfection Corporation.

ii. Fiber-reinforced plastic body.

iii. PE body tube.

iv. Buna-nitrile seals.

v. Acetal collets.

vi. Stainless-steel bolts, nuts, and washers.

7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) GE Oil & Gas.
- 2) Smith-Blair, Inc.

ii. Stainless-steel Steel flanges and tube with epoxy finish.

iii. Buna-nitrile seals.

iv. Stainless-steel Steel bolts, washers, and nuts.

v. Factory-installed anode for steel-body couplings installed underground.

## 2.03 PIPING SPECIALTIES

### A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

### B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

### C. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Basket Strainers:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

- F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

## 2.04 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

## 2.05 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
  1. CWP Rating: 125 psig.
  2. Threaded Ends: Comply with ASME B1.20.1.
  3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.



6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
  2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. A.Y. McDonald Mfg. Co.
    - ii. Apollo Flow Controls; Conbraco Industries, Inc.
    - iii. BrassCraft Manufacturing Co.; a Masco company.
  2. Body: Bronze, complying with ASTM B584.
  3. Ball: Chrome-plated brass.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE; blowout proof.
  6. Packing: Separate packnut with adjustable-stem packing threaded ends.
  7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  8. CWP Rating: 600 psig.
  9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. A.Y. McDonald Mfg. Co.
    - ii. Apollo Flow Controls; Conbraco Industries, Inc.
    - iii. BrassCraft Manufacturing Co.; a Masco company.
  2. Body: Bronze, complying with ASTM B584.
  3. Ball: Chrome-plated bronze.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE; blowout proof.
  6. Packing: Threaded-body packnut design with adjustable-stem packing.
  7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  8. CWP Rating: 600 psig.

9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. A.Y. McDonald Mfg. Co.
    - ii. Apollo Flow Controls; Conbraco Industries, Inc.
    - iii. BrassCraft Manufacturing Co.; a Masco company.
  2. Body: Bronze, complying with ASTM B584.
  3. Ball: Chrome-plated bronze.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE.
  6. Packing: Threaded-body packnut design with adjustable-stem packing.
  7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  8. CWP Rating: 600 psig.
  9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Bronze Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. A.Y. McDonald Mfg. Co.
    - ii. Lee Brass Company.
  2. Body: Bronze, complying with ASTM B584.
  3. Plug: Bronze.
  4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  5. Operator: Square head or lug type with tamperproof feature where indicated.
  6. Pressure Class: 125 psig.
  7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. A.Y. McDonald Mfg. Co.
    - ii. Mueller Co.
    - iii. Xomox Corporation.

2. Body: Cast iron, complying with ASTM A126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

I. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. A.Y. McDonald Mfg. Co.
  - ii. Flowserve Corporation.
  - iii. Mueller Co.
2. Body: Cast iron, complying with ASTM A126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

J. PE Ball Valves: Comply with ASME B16.40.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Kerotest Manufacturing Corp.
  - ii. Lyall, R. W. & Company, Inc.
  - iii. Perfection Corporation.
2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.

7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

K. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.06 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Eaton.
  - ii. Honeywell Building Solutions; Honeywell International, Inc.
  - iii. Johnson Controls.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. Normally closed.
6. Visual position indicator.
7. Electrical Mechanical operator for actuation by appliance automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Magnatrol Valve Corporation.
  - ii. Parker Hannifin Corporation.
  - iii. WATTS.
2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.

9. Visual position indicator.

## 2.07 EARTHQUAKE VALVES

### A. Earthquake Valves, Maximum Operating Pressure of 5 psig: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - i. Vanguard Valves, Inc.
2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

### B. Earthquake Valves, Maximum Operating Pressure of 60 psig: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - i. Pacific Seismic Products, Inc.
2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 60 psig.
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

## 2.08 DIELECTRIC FITTINGS

### A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

### B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Central Plastics Company.
  - ii. Matco-Norca.
  - iii. WATTS.
  - iv. Wilkins.
  - v. Zurn Industries, LLC.
2. Description:
  - i. Standard: ASSE 1079.

- ii. Pressure Rating: 125 psig minimum at 180 deg F.
- iii. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Central Plastics Company.
  - ii. Matco-Norca.
  - iii. WATTS.
  - iv. Wilkins.
- 2. Description:
  - i. Standard: ASSE 1079.
  - ii. Factory-fabricated, bolted, companion-flange assembly.
  - iii. Pressure Rating: 125 psig minimum at 180 deg F.
  - iv. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Advance Products & Systems, Inc.
  - ii. Calpico, Inc.
  - iii. Central Plastics Company.
- 2. Description:
  - i. Nonconducting materials for field assembly of companion flanges.
  - ii. Pressure Rating: 150 psig.
  - iii. Gasket: Neoprene or phenolic.
  - iv. Bolt Sleeves: Phenolic or polyethylene.
  - v. Washers: Phenolic with steel backing washers.

2.09 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

**PART 3 - EXECUTION**

3.01 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

### 3.03 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D2774.
- D. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
  - 3. Replace pipe having damaged PE coating with new pipe.
- E. Copper Tubing with Protective Coating:
  - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

### 3.04 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.

- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
  - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
  - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
  - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
  - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    - i. Exception: Tubing passing through partitions or walls does not require striker barriers.
  - 5. Prohibited Locations:
    - i. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    - ii. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.



- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.05 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

### 3.06 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  - 2. Cut threads full and clean using sharp dies.
  - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
  - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
  - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
  - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
  - 2. Bevel plain ends of steel pipe.
  - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

### 3.07 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for corrugated stainless-steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches of each fitting.
- F. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of corrugated stainless-steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.08 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

### 3.09 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.10 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  1. Alkyd System: MPI EXT 5.1D.
    - i. Prime Coat: Alkyd anticorrosive metal primer.
    - ii. Intermediate Coat: Exterior alkyd enamel matching topcoat.

- iii. Topcoat: Exterior alkyd enamel (semigloss).
  - iv. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
    - i. Prime Coat: Alkyd anticorrosive metal primer.
    - ii. Intermediate Coat: Interior latex matching topcoat.
    - iii. Topcoat: Interior latex (semigloss).
    - iv. Color: Gray.
  - 2. Alkyd System: MPI INT 5.1E.
    - i. Prime Coat: Alkyd anticorrosive metal primer.
    - ii. Intermediate Coat: Interior alkyd matching topcoat.
    - iii. Topcoat: Interior alkyd (semigloss).
    - iv. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

### 3.11 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

### 3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.14 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be the following:
  - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- B. Aboveground natural-gas piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
  - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
  - 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
  - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
  - 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with steel welding fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
  2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

### 3.17 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG

- A. Aboveground Piping: Maximum operating pressure more than 5 psig.
- B. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.
- C. Aboveground, distribution piping shall be the following:
1. Steel pipe with steel welding fittings and welded joints.
- D. Underground, below building, piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
  2. Steel pipe with wrought-steel fittings and welded joints.
- E. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- F. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

### 3.18 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
1. PE valves.
  2. NPS 2 and Smaller: Bronze plug valves.
  3. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

### 3.19 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
  2. Two-piece, full-port, bronze ball valves with bronze trim.
  3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
  2. Bronze plug valve.
  3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
  2. Two-piece, full-port, bronze ball valves with bronze trim.

3. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
  2. Bronze plug valve.
  3. Cast-iron, nonlubricated lubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
  2. Two-piece, full-port, bronze ball valves with bronze trim.
  3. Bronze plug valve.

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## SECTION 22 11 16

### DOMESTIC WATER PIPING

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Copper tube and fittings.
  - 2. Ductile-iron pipe and fittings.
  - 3. Piping joining materials.
  - 4. Encasement for piping.
  - 5. Transition fittings.
  - 6. Dielectric fittings.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For transition fittings and dielectric fittings.
- C. Sustainable Design Submittals:
  - 1. Product Data: For adhesives, indicating VOC content.
  - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

##### 1.05 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
  - 1. Notify Architect, Construction Manager and/or Owner no fewer than two days in advance of proposed interruption of water service.
  - 2. Do not interrupt water service without Architect's, Construction Manager's and/or Owner's written permission.



## **PART 2 - PRODUCTS**

### **2.01 PIPING MATERIALS**

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on applicable piping.

### **2.02 COPPER TUBE AND FITTINGS**

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type K water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
  - 1. MSS SP-123.
  - 2. Cast-copper-alloy, hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal seating surfaces.
  - 4. Solder-joint or threaded ends.
- F. Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Apollo Flow Controls; Conbraco Industries, Inc.
    - ii. Mueller Industries, Inc.
    - iii. NIBCO INC.
  - 2. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
  - 3. Minimum 200-psig working-pressure rating at 250 deg F.
- G. Appurtenances for Grooved-End Copper Tubing:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - i. Anvil International.
    - ii. Shurjoint-Apollo Piping Products USA Inc.
    - iii. Victaulic Company.
  - 2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
  - 3. Mechanical Couplings for Grooved-End Copper Tubing:
    - i. Copper-tube dimensions and design similar to AWWA C606.
    - ii. Ferrous housing sections.
    - iii. EPDM-rubber gaskets suitable for hot and cold water.
    - iv. Bolts and nuts.

- v. Minimum Pressure Rating: 300 psig.

## 2.03 DUCTILE-IRON PIPE AND FITTINGS

### A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

### B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

### C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

### D. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

### E. Appurtenances for Grooved-End, Ductile-Iron Pipe:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Shurjoint Piping Products USA Inc.
  - ii. Smith-Cooper International.
  - iii. Victaulic Company.
2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
3. Mechanical Couplings for Grooved-End, Ductile-Iron Piping:
  - i. AWWA C606 for ductile-iron-pipe dimensions.
  - ii. Ferrous housing sections.
  - iii. EPDM-rubber gaskets suitable for hot and cold water.
  - iv. Bolts and nuts.
  - v. Minimum Pressure Rating:
    - 1) NPS 14 to NPS 18: 250 psig.
    - 2) NPS 20 to NPS 46: 150 psig.

## 2.04 PIPING JOINING MATERIALS

### A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

### B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

### C. Solder Filler Metals: ASTM B 32, lead-free alloys.

- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.05 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

2.06 TRANSITION FITTINGS

A. General Requirements:

- 1. Same size as pipes to be joined.
- 2. Pressure rating at least equal to pipes to be joined.
- 3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Dresser, Inc.
  - ii. Jay R. Smith Mfg. Co.
  - iii. JCM Industries, Inc.

D. Plastic-to-Metal Transition Fittings:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Charlotte Pipe and Foundry Company.
  - ii. Harvel Plastics, Inc.
  - iii. Spears Manufacturing Company.
- 2. Description:
  - i. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
  - ii. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Colonial Engineering, Inc.
  - ii. NIBCO INC.
  - iii. Spears Manufacturing Company.

2. Description:

- i. CPVC or PVC four-part union.
- ii. Brass or stainless-steel threaded end.
- iii. Solvent-cement-joint or threaded plastic end.
- iv. Rubber O-ring.
- v. Union nut.

2.07 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Central Plastics Company.
  - ii. WATTS.
  - iii. Wilkins.
- 2. Standard: ASSE 1079.
- 3. Pressure Rating: 125 psig minimum at 180 deg F.
- 4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Central Plastics Company.
  - ii. WATTS.
  - iii. Wilkins.
- 2. Standard: ASSE 1079.
- 3. Factory-fabricated, bolted, companion-flange assembly.
- 4. Pressure Rating: 125 psig minimum at 180 deg F.
- 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Advance Products & Systems, Inc.
  - ii. Calpico, Inc.
  - iii. Central Plastics Company.
- 2. Nonconducting materials for field assembly of companion flanges.
- 3. Pressure Rating: 150 psig.

4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Elster Perfection Corporation.
  - ii. Grinnell G-Fire by Johnson Controls Company.
  - iii. Precision Plumbing Products.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

### **PART 3 - EXECUTION**

#### **3.01 EARTHWORK**

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

#### **3.02 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- H. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- N. Install piping to permit valve servicing.
- O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- P. Install piping free of sags and bends.
- Q. Install fittings for changes in direction and branch connections.
- R. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.03 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- H. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- I. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- J. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
  - 1. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following: Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
- K. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

#### 3.04 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

#### 3.05 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

#### 3.06 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
  - 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs:
    - i. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

- ii. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
  - iii. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
- 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
  - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
  - 6. NPS 6: 10 feet with 5/8-inch rod.
  - 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  - 3. NPS 2: 10 feet with 3/8-inch rod.
  - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
  - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
  - 7. NPS 6: 12 feet with 3/4-inch rod.
  - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.
- J. Install hangers for copper ductile iron tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- K. Support horizontal piping within 12 inches of each fitting.
- L. Support vertical runs of copper ductile iron tubing and piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.



- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
  - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
  - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

### 3.08 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

### 3.09 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Piping Inspections:
    - i. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - ii. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
    - iii. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    - iv. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
  - 2. Piping Tests:
    - i. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    - ii. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    - iii. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

- iv. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - v. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
  - vi. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.10 ADJUSTING

- A. Perform the following adjustments before operation:
- 1. Close drain valves, hydrants, and hose bibbs.
  - 2. Open shutoff valves to fully open position.
  - 3. Open throttling valves to proper setting.
  - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    - i. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    - ii. Adjust calibrated balancing valves to flows indicated.
  - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
  - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
  - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    - i. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - ii. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    - iii. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    - iv. Repeat procedures if biological examination shows contamination.
    - v. Submit water samples in sterile bottles to authorities having jurisdiction.

- B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
    - i. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - ii. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
  2. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
  3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
  - 4.
- F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
  2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- H. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.

2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
  1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
  2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
  3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
- J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:
  1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
  2. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
  3. Stainless-steel Schedule 10 or Schedule 40 pipe, grooved-joint fittings, and grooved joints.
- K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
  1. Plain-end, ductile-iron pipe, grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
  2. Stainless-steel Schedule 10 or Schedule 40 pipe, grooved-joint fittings, and grooved joints.

### 3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
  2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
  3. Hot-Water Circulation Piping, Balancing Duty: Calibrated or Memory-stop balancing valves.
  4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

**END OF SECTION**

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## SECTION 22 11 19

### DOMESTIC WATER PIPING SPECIALTIES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Automatic water shutoff valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose bibbs.
9. Drain valves.
10. Water-hammer arresters.
11. Trap-seal primer valves.
12. Trap-seal primer systems.
13. Flexible connectors.

###### B. Related Requirements:

1. Section 220519 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 224300 "Medical Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
4. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
5. Section 224713 "Drinking Fountains" for water filters for water coolers.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- B. Product Data: For each type of product.
- C. Shop Drawings: For domestic water piping specialties.
  - 1. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

**PART 2 - PRODUCTS**

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.
- B. Comply with NSF 372 for low lead.

2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. FEBCO; A WATTS Brand.
  - iii. WATTS.
  - iv. Zurn Industries, LLC.
- 2. Standard: ASSE 1001.
- 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
- 4. Body: Bronze.
- 5. Inlet and Outlet Connections: Threaded.
- 6. Finish: Rough bronze or Chrome plated.

- B. Hose-Connection Vacuum Breakers:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. WATTS.
  - iii. Zurn Industries, LLC.
- 2. Standard: ASSE 1011.

3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. FEBCO; A WATTS Brand.
  - iii. WATTS.
  - iv. Zurn Industries, LLC.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: Refer to Plumbing design drawings.
6. Design Flow Rate: Refer to Plumbing design drawings.
7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings.
8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings .
9. Accessories: Refer to Plumbing design drawings.
  - i. Valves: Ball type, on inlet and outlet.

D. Spill-Resistant Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. WATTS.
  - iii. Zurn Industries, LLC.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Size: NPS ¼, NPS 3/8, NPS 1/2, NPS 3/4 or NPS 1.
5. Accessories: Refer to Plumbing design drawings.
  - i. Valves: Ball type, on inlet and outlet.

2.04 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. FEBCO; A WATTS Brand.



- iii. WATTS.
    - iv. Zurn Industries, LLC.
  - 2. Standard: ASSE 1012.
  - 3. Operation: Continuous-pressure applications.
  - 4. Size: NPS 1/2 or NPS 3/4.
  - 5. Body: Bronze.
  - 6. End Connections: Union, solder joint.
  - 7. Finish: Chrome plated or Rough bronze.
- B. Reduced-Pressure-Principle Backflow Preventers:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following
    - i. Ames Fire & Waterworks; A WATTS Brand.
    - ii. FEBCO; A WATTS Brand.
    - iii. WATTS.
    - iv. Zurn Industries, LLC.
  - 2. Standard: ASSE 1013.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: 12 psig maximum, through middle third of flow range.
  - 5. Size: Refer to Plumbing design drawings.
  - 6. Design Flow Rate: Refer to Plumbing design drawings.
  - 7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings .
  - 8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings .
  - 9. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
  - 10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
  - 11. Configuration: Designed for horizontal, straight-through or vertical-inlet, horizontal-center-section, and vertical-outlet flow.
  - 12. Accessories:
    - i. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    - ii. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    - iii. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- C. Double-Check, Backflow-Prevention Assemblies:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - i. Apollo Flow Controls; Conbraco Industries, Inc.
    - ii. FEBCO; A WATTS Brand.

- iii. WATTS.
- iv. Zurn Industries, LLC.
- 2. Standard: ASSE 1015.
- 3. Operation: Continuous-pressure applications unless otherwise indicated.
- 4. Pressure Loss: 5 psig maximum, through middle third of flow range.
- 5. Size: Refer to Plumbing design drawings.
- 6. Design Flow Rate: Refer to Plumbing design drawings.
- 7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings.
- 8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings.
- 9. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
- 10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- 11. Configuration: Designed for horizontal, straight-through flow.
- 12. Accessories:
  - i. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
  - ii. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Dual-Check-Valve Backflow Preventers:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. FEBCO; A WATTS Brand.
  - iii. WATTS.
  - iv. Zurn Industries, LLC.
- 2. Standard: ASSE 1024.
- 3. Operation: Continuous-pressure applications.
- 4. Size: NPS 1/2, NPS 3/4, NPS 1 or NPS 1-1/4.
- 5. Body: Bronze with union inlet.

E. Reduced-Pressure-Detector, Fire-Protection, Backflow-Preventer Assemblies:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. FEBCO; A WATTS Brand.
  - iii. WATTS.
  - iv. Zurn Industries, LLC.
- 2. Standard: ASSE 1047 and is FM Global approved or UL listed.
- 3. Operation: Continuous-pressure applications.

4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Size: Refer to Plumbing design drawings.
6. Design Flow Rate: Refer to Plumbing design drawings.
7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings.
8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings .
9. Body: Cast iron or steel with interior lining that complies with AWWA C550 or that is FDA approved or Stainless steel.
10. End Connections: Flanged.
11. Configuration: Designed for horizontal, straight-through or vertical-inlet, horizontal-center-section, and vertical-outlet flow.
12. Accessories: Refer to Plumbing design drawings
  - i. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
  - ii. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
  - iii. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

F. Double-Check, Detector-Assembly Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. FEBCO; A WATTS Brand.
  - iii. WATTS.
  - iv. Zurn Industries, LLC.
2. Standard: ASSE 1048 and is FM Global approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: Refer to Plumbing design drawings.
6. Design Flow Rate: Refer to Plumbing design drawings.
7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings.
8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings.
9. Body: Cast iron or steel with interior lining that complies with AWWA C550 or that is FDA approved or Stainless steel.
10. End Connections: Flanged.
11. Configuration: Designed for horizontal, straight-through or vertical-inlet, horizontal-center-section, and vertical-outlet flow.
12. Accessories:
  - i. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

- ii. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

G. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. WATTS.
  - iii. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

H. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. FEBCO; A WATTS Brand.
  - iii. WATTS.
  - iv. Zurn Industries, LLC.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.05 AUTOMATIC WATER SHUTOFF VALVES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. DynaQuip Controls.
  2. FloLogic, Inc.
  3. OnSite PRO Inc.
  4. QMI Manufacturing Inc.
- B. Standards: NSF 61 and NSF 372.
- C. Shutoff Control Ball Valve:
1. Size: NPS 1/2, NPS 3/4, NPS 1, NPS 1-1/4, NPS 1-1/2 or NPS 2.
  2. Design Flow Rate: Refer to Plumbing design drawings.
  3. Design Inlet Pressure: Refer to Plumbing design drawings.
  4. Control Valve: Two-piece, full-port brass ball valve, MSS SP-110.
    - i. End Connections: Threaded, female.
    - ii. Seats: PTFE.
    - iii. O-Rings: FKM.

- iv. Stem: Low lead brass. Blowout proof.
  - v. CWP Rating: 600 psig.
- 5. Manual override control turn-knob for emergency operation of the valve.
- D. Shutoff Control Butterfly Valve:
  - 1. Size: NPS 2-1/2, NPS 3 or NPS 4.
  - 2. Compliance: MSS SP-67.
  - 3. Full-port, epoxy-coated, ductile-iron lug body.
  - 4. Seat: EPDM, minus 30 deg F to plus 250 deg F.
  - 5. Face-to-Face Flange: ASME B16.5 flanges.
  - 6. Disc Design: Floating stainless-steel dual shaft.
  - 7. Disc Material: Iron nylon 11 or Stainless steel.
  - 8. Locating Pin: Carbon steel.
  - 9. Bushings: PTFE.
  - 10. O-Rings: EPDM.
  - 11. Ten position stop.
  - 12. Manual override control turn-knob for emergency operation of the valve.
- E. Clothes Washer Shutoff Control Valve: Two-way, four-port, low-zinc bronze alloy valve.
  - 1. End Connections: Male hose connections, NPS 3/4.
  - 2. Pressure Rating: 400 psi at 32 to 150 deg F.
  - 3. Maximum Test Pressure: 1200 psig.
  - 4. Stem Travel: 0.16 inch.
  - 5. Maximum Temperature: 250 deg F.
  - 6. Valve Stem: Burnished Type 303 stainless steel.
  - 7. Valve Stem Packing: Double EPDM.
  - 8. Valve Seat: Integral bronze.
  - 9. Valve Disc and Plunger: EPDM.
  - 10. Valve Spring: Stainless steel.
  - 11. Hoses: Two, 9-inch steel braided.
  - 12. Hose End Connections: One straight and one 90-degree elbow connection; both hoses.
- F. Clothes Washer Shutoff Control Valve Actuator: Two position, drive closed, spring open.
  - 1. Housing: High-temperature composite glass-filled nylon.
  - 2. Connection to Valve: NPT female brass ring.
  - 3. Electric Motor: Reversible, brushless, and synchronism, maintains constant control speed to keep the cycle time constant. Maximum stem output is force balance controlled with electronic shutoff when end travel is detected in both directions.
  - 4. Maximum Working Force: 48 lbf.
  - 5. Power Requirements:

- i. Input Voltage: 24 V ac.
    - ii. Frequency: 60or 50 Hz.
    - iii. Current: 0.045 A.
    - iv. Power: 1 VA.
  - 6. Power Supply: 120-V ac to 24-V ac transformer with cord and plug.
  - 7. Working Time: 90 seconds.
  - 8. Duty Rating: 100 percent.
  - 9. Travel: 0.16 inch.
  - 10. Position Indicator: Standard.
  - 11. Working Temperature: 40 to 120 deg F.
  - 12. Conform to CE and ROHS requirements.
- G. Water Main Shutoff Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, two way; fails open/open or closed/closed.
- 1. Actuator Torque: 133or 266 in-lbf.
  - 2. Power Requirements:
    - i. Input Voltage: 12or 24 V dc.
    - ii. Frequency: 60or 50 Hz.
    - iii. Current: 2 A.
    - iv. Power: 15or 24 VA.
  - 3. Power Supply: 120-V ac to 12or 24-V dc transformer with cord and plug.
  - 4. Working Time: 8or 10 seconds.
  - 5. Torque Limiter: STD.
  - 6. Duty Rating: 50or 75 percent.
  - 7. Protection: IP65or IP67.
  - 8. Rotation: 90or 180 degrees.
  - 9. Manual Intervention: Allowed.
  - 10. Position Indicator: Standard.
  - 11. Working Temperature: Minus 4 deg F to plus 131 deg F.
- H. Domestic Water Heater Shutoff Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, two way; fails open/open or close/close.
- 1. Power Requirements:
    - i. Input Voltage: 24 V ac.
    - ii. Frequency: 60or 50 Hz.
    - iii. Current: 0.6 A.
    - iv. Power: 15 VA.
  - 2. Power Supply: 120-V ac to 24-V ac transformer with cord and plug.

3. Working Time: 45 seconds.
  4. Rotation: 90 degrees.
  5. Manual Intervention: Allowed.
  6. Position Indicator: LED for closed position.
  7. Working Temperature: 0 to 100 deg F.
  8. Audible Alarm: 83 dB.
- I. Actuator Enclosure: Suitable for ambient conditions encountered by application.
1. NEMA 250, Type 2 for indoor and protected applications.
  2. Material: Self-extinguishing class techno-polymer.
  3. .
- J. Wireless Leak Detection Receiver System:
1. Onboard Battery Backup: 48 hours of protection. Valve to close prior to backup failure.
  2. LED Indicators: Wireless signal strength, communication loss, water fault, low temperature fault, and low battery.
  3. Output Contacts: Interface with home security or building automation system, cellular text notification service, or auto dialer accessories.
  4. FCC Approved Wireless Communication System: Between devices; sensors, repeaters, and receivers:
    - i. Proprietary 900-MHz wireless communication platform ensures system operation without Wi-Fi dependence or other communication platforms, subject to power and random service outages.
    - ii. Automatic wireless communication testing and positive confirmation ensure system devices remain active and working correctly. Automatic fault notification for lost communication or missing device.
  5. Power Supply: 120 V ac or 9-V dc battery.
  6. Dual Function Wireless Sensors: 2. Valve closes if temperature falls below 45 deg F.
    - i. Wireless Signal Range: 100 feet between sensors and receiver.
    - ii. Custom range finding feature.
    - iii. LED Indicators: Wireless signal strength, communication loss, water fault, low temperature, and low battery.
  7. Self-monitoring enabled system; faults for lost communication between receiver and sensor(s).
  8. Closed-Loop RF System: System remains active even when power and Wi-Fi signals are lost.
- K. Wired Leak Detection System: Local water sensor.
1. Power Supply: Class II transformer with cord and plug, 120 V ac, UL listed.
    - i. Power Cord Length: 12 feet.
  2. Control Panel: LED power and LED valves indicator.
  3. Alarms: Audible alarm, with external output.
  4. Wired Sensors:

- i. Quantity Per Receiver: 1to 6.
  - ii. Cable Length: 8, 25, 50or 100 feet.
- 5. Sensor Elevation: Elevated 1/2 inches above condensate drain pan.
- L. Accessories:
  - 1. Water Flow Sensors: Pipe-mounted to detect water flow.
  - 2. Rope Sensor: Absorbent water sensing rope constructed from twisted metal conductor wires insulated from one another and surrounded by polyethylene mesh braid jacket. Connect up to 100 feet (10 sections) of sensor rope to a single receiver.
  - 3. Electrical Plug Interrupter: Plugs into standard 120-V ac wall outlet.
  - 4. Gas Flow Interrupter: ECO Connector with female spade connectors. Factory prewired, 8 feet.
  - 5. Gas Interface Cable: Interface cable with male and female connectors.
  - 6. Step-Down Transformer: 120, 208or 240 V ac to 24 V ac with mounting plate, 12-foot plenum wire to power, and 8-foot plenum wire to sensor.
  - 7. Liquid Level Sensors: Monitor fluid levels in addition to detecting plumbing leaks.
  - 8. Auto Dialer: Send and receive automatic alerts when a fault condition occurs. Standard output contacts trigger up to nine predetermined telephone number calls.
    - i. Prerecord message for future playback.
    - ii. 10-second recordable message.
    - iii. Built-in tamper switch.
    - iv. DC adaptor with battery backup.
    - v. Programmable as a silent (dialer only) or audible (siren and dialer) alarm.
    - vi. Easy "Stop Call Sequence" - push "#" on phone to acknowledge the alarm and stop the dialing sequence.
  - 9. Cellular Text Notification System.
    - i. Event SMS text notification to up to three cell phones.
    - ii. Battery backup, four (4) AA batteries.
    - iii. 12-foot interface cable to leak detection system.
    - iv. Customized messaging.
    - v. Wireless network service provider.
  - 10. Cable Adder: 10, 25, 50or 100 feet in length.
  - 11. Wireless Signal Repeater: Boosts signal performance between wireless sensors and receiver.
    - i. Push-button pairing and unpairing, into and out of the network.
    - ii. Visual indication of wireless signal strength, low battery, and lost communication.
    - iii. Standard wall outlet, 120 V ac, power.
    - iv. Battery backup: Two (2) AA batteries for battery backup to maintain system integrity during a power outage.



12. Wireless Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.
13. Hard-Wired Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.

## 2.06 BALANCING VALVES

### A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Armstrong International, Inc.
  - ii. ITT Corporation.
  - iii. NIBCO INC.
  - iv. TACO Comfort Solutions, Inc.
  - v. WATTS.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
3. Body: Brass or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

### B. Cast-Iron Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Armstrong International, Inc.
  - ii. ITT Corporation.
  - iii. NIBCO INC.
  - iv. WATTS.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

### C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

### D. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. Milwaukee Valve Company.
  - iii. NIBCO INC.
  - iv. Red-White Valve Corp.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.

3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

## 2.07 TEMPERATURE-ACTUATED, WATER MIXING VALVES

### A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. Leonard Valve Company.
  - iii. POWERS; A WATTS Brand.
  - iv. Symmons Industries, Inc.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: Refer to Plumbing design drawings.
9. Tempered-Water Design Flow Rate: Refer to Plumbing design drawings.
10. Valve Finish: Chrome plated or Rough bronze.

### B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Lawler Manufacturing Company, Inc.
  - ii. Leonard Valve Company.
  - iii. POWERS; A WATTS Brand.
  - iv. Symmons Industries, Inc.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted or Cabinet-type, thermostatically controlled, water mixing valve.

5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: Refer to Plumbing design drawings.
9. Tempered-Water Design Flow Rate: Refer to Plumbing design drawings.
10. Selected Valve Flow Rate at 45-psig Pressure Drop: Refer to Plumbing design drawings.
11. Pressure Drop at Design Flow Rate: Refer to Plumbing design drawings.
12. Valve Finish: Polished, chrome plated or Rough bronze.
13. Piping Finish: Chrome plated or Copper.
14. Cabinet: Factory fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless-steel door.

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Apollo Flow Controls; Conbraco Industries, Inc.
  - ii. Lawler Manufacturing Company, Inc.
  - iii. Leonard Valve Company.
  - iv. POWERS; A WATTS Brand.
  - v. WATTS.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: Refer to Plumbing design drawings.
9. Tempered-Water Design Flow Rate: Refer to Plumbing design drawings.

D. Primary Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Heat-Timer Corporation.
  - ii. Holby Valve Inc.
  - iii. Uponor.
2. Standard: ASSE 1017, thermostatically controlled, water tempering valve, listed as tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.

4. Body: Bronze.
5. Temperature Control: Manual.
6. Inlets and Outlet: Threaded.
7. Selected Primary Water Tempering Valve Size: Refer to Plumbing design drawings.
8. Tempered-Water Setting: Refer to Plumbing design drawings.
9. Tempered-Water Design Flow Rate: Refer to Plumbing design drawings.
10. Pressure Drop at Design Flow Rate: Refer to Plumbing design drawings.
11. Tempered-Water Outlet Size: Refer to Plumbing design drawings.
12. Cold-Water Inlet Size: Refer to Plumbing design drawings.
13. Hot-Water Inlet Size: Refer to Plumbing design drawings.
14. Valve Finish: Rough bronze.

## 2.08 STRAINERS FOR DOMESTIC WATER PIPING

### A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
  - i. Strainers NPS 2 and Smaller: 0.020, 0.033 or 0.062 inch.
  - ii. Strainers NPS 2-1/2 to NPS 4: 0.045, 0.062 or 0.125 inch.
  - iii. Strainers NPS 5 and Larger: 0.10, 0.125 or 0.25 inch.
6. Drain: Pipe plug and Factory-installed, hose-end drain valve.

## 2.09 OUTLET BOXES

### A. Ice maker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. IPS Corporation.
  - ii. LSP Products Group, Inc.
  - iii. Oatey.
  - iv. Plastic Oddities.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel, epoxy-painted-steel Stainless-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

## 2.10 HOSE BIBBS

### A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. MIFAB, Inc.
  - iii. WATTS.
  - iv. Woodford Manufacturing Company.
  - v. Acorn Manufacturing
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig.
8. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Rough bronze, Chrome or nickel plated.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Equipment Rooms: Wheel handle or operating key.
13. Operation for Service Areas: Wheel handle or Operating key.
14. Operation for Finished Rooms: Wheel handle or Operating key.
15. Include operating key with each operating-key hose bibb.
16. Include integral wall flange with each chrome- or nickel-plated hose bibb.

## 2.11 DRAIN VALVES

### A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. MIFAB, Inc.
  - ii. Precision Plumbing Products.
  - iii. Sioux Chief Manufacturing Company, Inc.
  - iv. WATTS.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. MIFAB, Inc.
  - iii. Precision Plumbing Products.
  - iv. Sioux Chief.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.

6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Jay R. Smith Mfg. Co.
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

2.14 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Precision Plumbing Products.
  - ii. Zurn Industries, LLC.
2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B88, Type L; copper, water tubing.
4. Cabinet: Recessed or Surface-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
  - i. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Refer to Plumbing design drawings.
8. Size Outlets: NPS 1/2 or NPS 5/8.

2.15 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. Flex-Hose Co., Inc.
  2. Flex-Weld, Inc.
  3. Metraflex Company (The).
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
  1. Working-Pressure Rating: Minimum 200 psig or 250 psig.
  2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
  3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
  - 1. Working-Pressure Rating: Minimum 200 psig or 250 psig.
  - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
  - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Backflow Preventers: Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Locate backflow preventers in same room as connected equipment or system.
  - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
  - 3. Do not install bypass piping around backflow preventers.
- B. Water Regulators: Install with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Water Control Valves: Install with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- D. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve and downstream from fire sprinkler system supply. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.
- E. Balancing Valves: Install in locations where they can easily be adjusted.
- F. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- G. Y-Pattern Strainers: For water, install on supply side of each control valve, water pressure-reducing valve, solenoid valve and/or pump.
- H. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- I. Water-Hammer Arresters: Install in water piping according to PDI-WH 201.
- J. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- K. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- L. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.



### 3.02 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.
- C. Comply with requirements for grounding equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.03 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Pressure vacuum breakers.
  - 2. Intermediate atmospheric-vent backflow preventers.
  - 3. Reduced-pressure-principle backflow preventers.
  - 4. Double-check, backflow-prevention assemblies.
  - 5. Dual-check-valve backflow preventers.
  - 6. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
  - 7. Double-check, detector-assembly backflow preventers.
  - 8. Water pressure-reducing valves.
  - 9. Automatic water shutoff valves.
  - 10. Calibrated balancing valves.
  - 11. Primary, thermostatic, water mixing valves.
  - 12. Manifold, thermostatic, water mixing-valve assemblies.
  - 13. Primary water tempering valves.
  - 14. Outlet boxes.
  - 15. Supply-type, trap-seal primer valves.
  - 16. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check, backflow-prevention assembly and/or double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.05 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

**END OF SECTION**

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## SECTION 22 13 16

### SANITARY WASTE AND VENT PIPING

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Hubless, cast-iron soil pipe and fittings.
2. Copper tube and fittings.
3. Specialty pipe fittings.
4. Encasement for underground metal piping.

###### B. Related Requirements:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

###### B. Product Data: For each type of product.

###### C. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

###### D. Shop Drawings: For hubless, single-stack drainage system include plans, elevations, sections, and details.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.05 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Architect's, Construction Manager's and Owner's written permission.

1.06 WARRANTY

A. Listed manufacturers to provide labelling and warranty of their respective products.

**PART 2 - PRODUCTS**

2.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.
2. Waste, Force-Main Piping: 50 psig, 100 psig or 150 psig.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.02 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - i. ANACO-Husky.
  - ii. Charlotte Pipe and Foundry Company.
  - iii. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - i. ANACO-Husky.
  - ii. Charlotte Pipe and Foundry Company.
  - iii. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C1277 and ASTM C1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.04 COPPER TUBE AND FITTINGS

- A. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B88, Type L and Type M, water tube, drawn temper.
- D. Copper Pressure Fittings:
  1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
  2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
  1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
  2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- F. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.05 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
  1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
  2. Shielded, Nonpressure Transition Couplings:
    - i. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      - 1) Cascade Waterworks Mfg. Co.
      - 2) Mission Rubber Company, LLC; a division of MCP Industries.
    - ii. Standard: ASTM C1460.

- iii. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- iv. End Connections: Same size as and compatible with pipes to be joined.

2.06 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A674 or AWWA C105/A 21.5.
- B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Natural.

**PART 3 - EXECUTION**

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
  - 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Provide seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. All cleanouts shall be installed where readily accessible. The contractor shall coordinate all cleanout locations with equipment, cabinets, etc. and architect prior to any installation.
- L. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
  - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.

2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - i. Straight tees, elbows, and crosses may be used on vent lines.
  3. Do not change direction of flow more than 90 degrees.
  4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - i. Reducing size of waste piping in direction of flow is prohibited.
- M. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  3. Maintain swab in piping and pull past each joint as completed.
- N. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 or 2 percent downward in direction of flow for piping NPS 4 and larger.
  2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
  3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- O. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A674 or AWWA C105/A 21.5.
- P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- Q. Install engineered soil and waste and vent piping systems as follows:
1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
  2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
  3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- R. Install underground, ductile-iron, force-main piping according to AWWA C600.
1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
  2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
  3. Install encasement on piping according to ASTM A674 or AWWA C105/A 21.5.
- S. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
1. Install encasement on piping according to ASTM A674 or AWWA C105/A 21.5.
- T. Install force mains at elevations indicated.
- U. Plumbing Specialties:
1. Install backwater valves in sanitary waster gravity-flow piping.



- i. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
  - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
    - i. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
    - ii. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
  - 3. Install drains in sanitary waste gravity-flow piping.
    - i. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors.
  - 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs.
  - 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.
  - 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.03 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
  - 1. Cut threads full and clean using sharp dies.
  - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - i. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    - ii. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    - iii. Do not use pipe sections that have cracked or open welds.
- E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints according to ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

- G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

### 3.04 SPECIALTY PIPE FITTING INSTALLATION

#### A. Transition Couplings:

- 1. Install transition couplings at joints of piping with small differences in ODs.
- 2. In Waste Drainage Piping: Unshielded or Shielded, nonpressure transition couplings.
- 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
- 4. In Underground Force Main Piping:
  - i. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
  - ii. NPS 2 and Larger: Pressure transition couplings.

#### B. Dielectric Fittings:

- 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
- 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.
- 4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

### 3.05 VALVE INSTALLATION

#### A. Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.

#### B. Shutoff Valves:

- 1. Install shutoff valve on each sewage pump discharge.
- 2. Install full-port ball valve for piping NPS 2 and smaller.
- 3. Install gate valve for piping NPS 2-1/2 and larger.

#### C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

#### D. Backwater Valves: Install backwater valves in piping subject to backflow.

- 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
- 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
- 3. Install backwater valves in accessible locations.
- 4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

### 3.06 HANGER AND SUPPORT INSTALLATION

#### A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment." and Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
  2. Install stainless-steel or fiberglass pipe hangers for horizontal piping in corrosive environments.
  3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
  4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
  5. Vertical Piping: MSS Type 8 or Type 42, clamps.
  6. Install individual, straight, horizontal piping runs:
    - i. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - ii. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - iii. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
  7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
  2. NPS 3: 60 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
  4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
  5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
  6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2: 84 inches with 3/8-inch rod.
  2. NPS 3: 96 inches with 1/2-inch rod.
  3. NPS 4: 108 inches with 1/2-inch rod.
  4. NPS 6: 10 feet with 5/8-inch rod.
- J. Install supports for vertical stainless-steel piping every 10 feet.
- K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
  2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  3. NPS 2-1/2: 108 inches with 1/2-inch rod.
  4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
  5. NPS 6: 10 feet with 5/8-inch rod.
  6. NPS 8: 10 feet with 3/4-inch rod.
- L. Install supports for vertical copper tubing every 10 feet.
- M. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

### 3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
  2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
  4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
  5. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.
  6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
  7. Equipment: Connect waste piping as indicated.
    - i. Provide shutoff valve if indicated and union for each connection.
    - ii. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main.
  2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### 3.08 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.

- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.09 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - i. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
    - i. Expose work that was covered or concealed before it was tested.
  - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
    - i. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    - ii. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    - iii. Inspect joints for leaks.
  - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
    - i. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
    - ii. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    - iii. Air pressure must remain constant without introducing additional air throughout period of inspection.
    - iv. Inspect plumbing fixture connections for gas and water leaks.
  - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  - 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
  - i. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
  - i. Isolate test source and allow to stand for four hours.
  - ii. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

### 3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Cover all floor drains and floor sinks during constructions to prevent debris from entering pipe and protect grates from damages.
- D. Place plugs in ends of uncompleted piping at end of day and when work stops.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

### 3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
  3. Galvanized-steel pipe, drainage fittings, and threaded joints.
  4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
  5. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
  3. Galvanized-steel pipe, drainage fittings, and threaded joints.
  4. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
  3. Galvanized-steel pipe, drainage fittings, and threaded joints.

4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
    - i. Option for Vent Piping, NPS 2-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
  5. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
  3. Galvanized-steel pipe, drainage fittings, and threaded joints.
  4. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Extra Heavy or Service class, cast-iron soil piping; gaskets; and gasketed or calking materials; and calked joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty cast-iron hubless-piping couplings; and coupled joints.
  3. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
1. Extra Heavy or Service class, cast-iron soil piping; gaskets; and gasketed or calking materials; and calked joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty cast-iron hubless-piping couplings; coupled joints.
  3. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
  2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
  2. Galvanized-steel pipe, pressure fittings, and threaded joints.
  3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- J. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:
1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
  2. Ductile-iron, mechanical-joint piping and mechanical joints.
  3. Ductile-iron, push-on-joint piping and push-on joints.
  4. Ductile-iron, grooved-joint piping and grooved joints.
  5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 and larger shall be any of the following:

1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

**END OF SECTION**

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## SECTION 22 13 19

### SANITARY WASTE PIPING SPECIALTIES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Roof flashing assemblies.
4. Through-penetration firestop assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Floor drains.
7. Floor sinks.

###### B. Related Requirements:

1. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Section 224300 "Healthcare Plumbing Fixtures" for plaster sink interceptors.
3. Section 334200 "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

##### 1.03 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene.
- B. FOG: Fats, oils, and greases.
- C. PVC: Polyvinyl chloride.
- D. FRP: Fiberglass-reinforced plastic.
- E. HDPE: High-density polyethylene.
- F. PE: Polyethylene.
- G. PP: Polypropylene.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  1. "No Exception Taken".
  2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories for the following:

1. FOG disposal systems.

C. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.
2. Wiring Diagrams: Power, signal, and control wiring.

#### 1.05 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: For FOG disposal systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

#### 1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

### **PART 2 - PRODUCTS**

#### 2.01 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

#### 2.02 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, available manufactures offering products that may be incorporated into the work include but are not limited to the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. MIFAB, Inc.
  - iii. Zurn Industries, LLC.
2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or hubless.

7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed or open for airflow unless subject to backflow condition.
8. Extension: ASTM A74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. WATTS.
  - iii. Zurn Industries, LLC.
2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.03 CLEANOUTS

A. Cast-Iron Exposed Cleanouts: :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. MIFAB, Inc.
  - iii. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Stainless-Steel Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. BLÜCHER; A Watts brand.
  - ii. Josam Company.
  - iii. Watts.
2. Standard: ASME A112.3.1.
3. Size: Same as connected drainage piping
4. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
5. Closure: Stainless-steel plug with seal.

C. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. Josam Company.
  - iii. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing or threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing or threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: As Required.
7. Outlet Connection: Inside calk, Spigot, or Threaded.
8. Closure: Brass plug with straight threads and gasket or Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads or setscrews.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy Polished bronze, or Rough bronze.
11. Frame and Cover Shape: Round, or Square when specifically requested by owner.
12. Top Loading Classification: Heavy duty at exterior locations. Light or Medium Duty within building.
13. Riser: ASTM A74, Extra-Heavy or Service class, cast-iron drainage pipe fitting and riser to cleanout.

D. Stainless-Steel Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. BLÜCHER; A Watts brand.
  - ii. Josam Company.
  - iii. Kusel Equipment Co.
2. Standard: ASME A112.3.1.
3. Size: Same as connected branch.
4. Housing: Stainless steel.
5. Closure: Stainless steel with seal.
6. Riser: ASTM A74, Extra-Heavy or Service class, stainless-steel drainage pipe fitting and riser to cleanout.
7. Body or Ferrule: Stainless steel.
8. Clamping Device: as Required.
9. Outlet Connection: Inside calk, Spigot, or Threaded.
10. Closure: Brass plug with straight threads and gasket, or Brass plug with tapered threads.

11. Adjustable Housing Material: Cast iron with threads or setscrews.
12. Frame and Cover Material and Finish: Nickel-bronze, copper alloy, or Stainless steel.
13. Frame and Cover Shape: Round or Square when specifically requested by owner.
14. Top Loading Classification: Heavy duty at exterior locations. Light or Medium Duty within building.

E. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. MIFAB, Inc.
  - iii. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch, or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
  - i. Brass Cast iron.
  - ii. Countersunk or raised head.
  - iii. Drilled and threaded for cover attachment screw.
  - iv. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.04 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Acorn Engineering Company.
  - ii. Thaler Metal Industries Ltd.
  - iii. Zurn Industries, LLC.
2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
  - i. Open-Top Vent Cap: Without cap.
  - ii. Low-Silhouette Vent Cap: With vandal-proof vent cap.
  - iii. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.05 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - i. ProVent Systems.
2. Standard: UL 1479 assembly of sleeve-and-stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A48/A48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

## 2.06 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

### A. Open Drains:

1. Description: Shop or field fabricate from ASTM A74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
2. Size: Same as connected waste piping.

### B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
  - i. NPS 2: 4-inch-minimum water seal.
  - ii. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

### C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

### D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

### E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch to 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.07 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. MIFAB, Inc.
  - iii. WATTS.
  - iv.
2. Standard: ASME A112.6.3 with backwater valve where required.
3. Pattern: Area or Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: As Required.
6. Anchor Flange: As Required.
7. Clamping Device: As Required.
8. Outlet: Bottom.
9. Backwater Valve: Drain-outlet type or Integral, ASME A112.14.1, swing-check type.
10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
11. Sediment Bucket: As Required.
12. Top or Strainer Material: Nickel bronze or Stainless steel.
13. Top of Body and Strainer Finish: Nickel bronze or Stainless steel.



14. Top Shape: Round. Square when specifically requested by owner.
  15. Dimensions of Top or Strainer: Refer to Plumbing Fixture Schedule on Construction Plans for body, sump, and grate requirements.
  16. Top Loading Classification: Heavy duty at exterior locations. Light or Medium Duty within building.
  17. Funnel: Not required.
  18. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
  19. Trap Material: Bronze, Cast iron or Copper.
  20. Trap Pattern: Deep-seal P-trap or Standard P-trap.
  21. Trap Features: Trap-seal primer valve drain connection.
- B. Stainless-Steel Floor Drains, ASME A112.3.1:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - i. Zurn Industries, LLC.
  2. Outlet: Bottom or Side.
  3. Top or Strainer Material: Stainless steel.
  4. Top Shape: Round. Square when specifically requested by owner.
  5. Dimensions of Top or Strainer: Refer to Plumbing Fixture Schedule on Construction Plans for body, sump, and grate requirements.
  6. Seepage Flange: As Required.
  7. Anchor Flange: As Required.
  8. Clamping Device: As Required.
  9. Trap-Primer Connection: Required.
  10. Trap Material: Stainless steel.
  11. Trap Pattern: Deep-seal P-trap or Standard P-trap.

## 2.08 FLOOR SINKS

### A. Cast-Iron Floor Sinks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. MIFAB, Inc.
  - iii. Watts; a Watts Water Technologies company.
  - iv.
2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: As Required, with seepage holes.

6. Clamping Device: As Required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Not required.
10. Internal Strainer: Dome or Flat.
11. Internal Strainer Material: Aluminum.
12. Top Grate Material: Cast iron, loose.
13. Top of Body and Grate Finish: Nickel bronze, Acid-resistant enamel.
14. Top Shape: Square.
15. Dimensions of Top Grate: Refer to Plumbing Fixture Schedule on Construction plans.
16. Top Loading Classification: No traffic.
17. Funnel: Not required.

#### 2.09 MOTORS

- A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
  1. Motor Sizes: Minimum size as indicated. If not indicated, motor shall be large enough, so driven load will not require motor to operate in service factor range above 1.0.

### **PART 3 - EXECUTION**

#### 3.01 INSTALLATION

- A. Equipment Mounting:
  1. Comply with requirements for vibration-isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
  2. Comply with requirements for vibration-isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
- B. Install backwater valves in building drain piping.
  1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in building drain piping according to the following, unless otherwise indicated:
  1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  2. Locate at each change in direction of piping greater than 135 degrees.
  3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  4. Locate at base of each vertical soil and waste stack.
  5. At each horizontal drainage pipe upper terminal.
  6. Above each Urinal.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping."
- I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  - 2. Size: Same as floor drain inlet.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- M. Install vent caps on each vent pipe passing through roof.
- N. In freeze prone areas install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. In freeze prone areas install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- Q. Install wood-blocking reinforcement for wall-mounting-type specialties.
- R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- S. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
    - i. Maintain integrity of waterproof membranes where penetrated.
  - 2. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- T. Install trench drains at low points of surface areas to be drained.
  - 1. Set grates of drains flush with finished surface, unless otherwise indicated.
- U. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
  - 1. Install on support devices, so that top will be flush with adjacent surface.
- V. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

- W. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

### 3.02 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- E. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- F. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- G. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

### 3.03 FLASHING INSTALLATION

- A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.
- C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- D. Set flashing on floors and roofs in solid coating of bituminous cement.
- E. Secure flashing into sleeve and specialty clamping ring or device.
- F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

### 3.04 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the equipment.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
  - 1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.06 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Section 017900 "Demonstration and Training."

**END OF SECTION**

## SECTION 22 16 19

### DISINFECTION OF POTABLE WATER SYSTEM

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

- A. This section includes the furnishing of all labor and materials for disinfection of the potable water system. Potable water systems are those systems which carry domestic water from the supply main without isolation of the branch by a backflow prevention device. Install all plumbing fittings and valves necessary to perform the disinfection.
- B. This section also includes the furnishing of all labor and materials to sample water in system following completion of procedure and provide bacteriological analysis of the water.

##### 1.02 QUALIFICATIONS

- A. Disinfection: Disinfection shall be done by a commercial disinfection company approved by the Client. Submit to the Client's Representative the name of the proposed company for approval.
- B. Bacteriological Analysis: Water testing shall be done by a laboratory approved by the State Department of Health Services. Submit for approval the name of the proposed laboratory as well as the proposed number and location of samples.
- C. Provide a certificate of completion per Part B attached standard chlorination report which denotes the lines disinfected, the concentration applied and the amount and type of disinfection agent used, and that disinfection is in accordance with AWWA C-601 and State Health Department requirements.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All exceptions shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product.

#### **PART 2 - PRODUCTS**

##### 2.01 MATERIALS

- A. Use an approved chlorine agent, applied in liquid form into the system being disinfected. Chlorine gas or a hypochlorite solution may be used to make up the disinfecting liquid.

#### **PART 3 - EXECUTION**

##### 3.01 PRELIMINARY PREPARATION OF THE SYSTEM

- A. Provide within 3 feet of the supply main, an injection port for introducing the chlorine solution and a gate valve upstream from the injection port.

- B. There shall be no dead-end sections in the system exceeding 18 inches in length. All branches within the system shall lead to an outlet for bleeding and flushing.
- C. After final pressure tests, open each fixture or outlet to maximum flow and run until the discharge water is free from particulates.

### 3.02 CHLORINATION PROCEDURE

- A. Notify the University's Representative at least five working days prior to the start date of chlorination per Part A attached chlorination report.
- B. Install all fixtures to be served by the potable water system before start of chlorination.
- C. Prior to injection, place signs on each fixture being treated, reading "Heavily Chlorinated Water - Do Not Use."
- D. Introduce the chlorine into the supply stream at a rate to provide a uniform concentration of chlorine in the entire system. Maintain at least 50 ppm chlorine level at each fixture after a hold period of 24 hours.
- E. Draw the injected chlorine in the system through each outlet and fixture until the specified concentration level is reached. Then close all valves including the service cock and supply valve. Keep the system closed during the 24 hour hold period.
- F. The Client will require a test for the residual concentration in the system at the end of 24 hours. Release no water from the system until these required samples are taken. A minimum concentration of 50 ppm of chlorine is required at all chosen sampling points.
- G. After approval to proceed, flush the system at a relatively high velocity to remove the injected chlorine to a concentration in the system of no more than 0.5 ppm above that in the normal supply.
- H. After approval to proceed, secure the entire system for at least three days prior to taking samples for bacteriological analysis.

### 3.03 SAMPLING AND NOTIFICATION

- A. At the completion of the three-day hold period, take bacteriological water samples with observation by the Client's Representative.
- B. Sample bottles must be provided by the approved laboratory. After the samples have been collected, the Client's Representative may allow temporary use of the water system pending results of the bacteriological analysis of the samples. The system cannot be used unless such allowance in writing is given.
- C. Upon completion of sampling, submit the certificate of completion to the Client's Representative for approval.

### 3.04 ANALYSIS

- A. Perform qualitative and quantitative bacterial analysis on the water samples and submit a laboratory report. The report must include the presence of any E. Coli bacteria in a 100 ml sample (this must be negative to be acceptable) and a total plate count of bacteria per cc of the sample (this must be less than 100, or equal to the supply).

### 3.05 FINAL ACCEPTANCE

- A. Upon satisfactory completion of all procedures and receipt of acceptable bacteriological results, written approval of the system will be provided by the Client's Representative per Part C attached standard chlorination report. Failure to fully comply with the above procedures will result in a requirement to repeat the procedure until acceptable results are achieved, at no additional cost to the Client.

## **END OF SECTION**

## SECTION 22 40 00

### PLUMBING FIXTURES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Water closets.
2. Water closet Flushometer valves and tanks.
3. Toilet seats.
4. Urinals.
5. Urinal Flushometer valves.
6. Lavatories.
7. Lavatory Faucets.
8. Handwash sinks.
9. Sink faucets.
10. Laminar-flow, faucet-spout outlets.
11. Lavatory and Sink Supply Fittings.
12. Lavatory and Sink Waste Fittings.
13. Grout.
14. Supports. Service basins.
15. Utility sinks.

###### B. Related Requirements:

1. Section 224713 "Drinking Fountains" for drinking fountain units.

##### 1.03 DEFINITIONS

- A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.
- B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  1. "No Exception Taken".
  2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.



B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.

1. Water Closet Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.
2. Urinal Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.
3. Waterless Urinal Trap-Seal Cartridges: Equal to 200 percent of amount of each type installed, but no fewer than 12 of each type.
4. Waterless Urinal Trap-Seal Liquid: Equal to 1 gal. for each urinal installed.

**PART 2 - PRODUCTS**

2.01 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets: Floor mounted, bottom outlet, top spud.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. American Standard.
  - ii. FNW; Ferguson Enterprises, Inc.
  - iii. Gerber Plumbing Fixtures LLC.
  - iv. Kohler Co.
  - v. Mansfield Plumbing Products LLC.
  - vi. Sloan Valve Company.
  - vii. TOTO USA, INC.
  - viii. Zurn Industries, LLC.
2. Bowl:
  - i. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
  - ii. Material: Vitreous china.
  - iii. Type: Siphon jet.
  - iv. Style: Flushometer valve.
  - v. Height: Refer to Fixture Schedule on P002.

- vi. Rim Contour: Elongated.
- vii. Water Consumption: 1.28 gal. per flush.
- viii. Spud Size and Location: NPS 1-1/2; top.
- ix. Color: White.
- 3. Bowl-to-Drain Connecting Fitting: ASTM A1045 or ASME A112.4.3.
- 4. Flushometer Valve: Refer to Fixture Schedule on P002.
- 5. Toilet Seat: Refer to Fixture Schedule on P002.
- B. Water Closets: Floor mounted, bottom outlet, back spud.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Gerber Plumbing Fixtures LLC.
    - ii. Kohler Co.
    - iii. Zurn Industries, LLC.
  - 2. Bowl:
    - i. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - ii. Material: Vitreous china.
    - iii. Type: Siphon jet.
    - iv. Style: Flushometer valve.
    - v. Height: Standard.
    - vi. Rim Contour: Elongated.
  - 3. Water Consumption: 1.28 gal. per flush.
    - i. Spud Size and Location: NPS 1-1/2; back.
    - ii. Color: White.
  - 4. Bowl-to-Drain Connecting Fitting: ASTM A1045 or ASME A112.4.3.
  - 5. Flushometer Valve: Refer to Fixture Schedule on P002.
  - 6. Toilet Seat: Refer to Fixture Schedule on P002.
- C. Water Closets: Floor mounted, bottom outlet, close-coupled flushometer tank.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Kohler Co.
    - ii. Zurn Industries, LLC.
  - 2. Bowl:
    - i. Standards: ASME A112.19.2/CSA B45.1 and ASSE/ASME 1037/CSA B125.37.
    - ii. Material: Vitreous china.
    - iii. Type: Siphon jet.
    - iv. Style: Pressure assisted.
    - v. Height: Refer to Fixture Schedule on P002.

- vi. Rim Contour: Elongated.
  - vii. Water Consumption: Maximum 1.28 gal per flush.
  - viii. Color: White.
- 3. Bowl-to-Drain Connecting Fitting: ASTM A1045 or ASME A112.4.3.
- 4. Flushometer Tank: Pressure assisted.
- 5. Toilet Seat: Refer to Fixture Schedule on P002.
- D. Water Closets: Floor mounted, bottom outlet, child's.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Kohler Co.
    - ii. Sloan Valve Company.
    - iii. Zurn Industries, LLC.
  - 2. Bowl:
    - i. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - ii. Material: Vitreous china.
    - iii. Type: Siphon jet or reverse trap.
    - iv. Style: Flushometer valve.
    - v. Height: Child.
    - vi. Rim Contour: Modified elongated or regular.
    - vii. Water Consumption: 1.28 gal. per flush.
    - viii. Spud Size and Location: NPS 1-1/2, back.
    - ix. Color: White.
  - 3. Bowl-to-Drain Connecting Fitting: ASTM A1045 or ASME A112.4.3.
  - 4. Flushometer Valve: Refer to Fixture Schedule on P002.
  - 5. Toilet Seat: IAPMO/ANSI Z124.5, Shape 3 (elongated rim), open front, without cover, and shaped to match bowl.

## 2.02 FLUSHOMETER VALVES

### A. Lever-Handle, Diaphragm Flushometer Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Gerber Plumbing Fixtures LLC.
  - ii. Sloan Valve Company.
  - iii. Zurn Industries, LLC.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig.
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.

7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Consumption: 1.28 gal. per flush.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.

B. Solenoid-Actuator, Diaphragm Flushometer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Gerber Plumbing Fixtures LLC.
  - ii. Sloan Valve Company.
  - iii. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Consumption: 1.28 gal. Insert value per flush.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

C. Hydraulic-Actuator, Push-Button, Diaphragm Flushometer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Delany Products.
  - ii. Sloan Valve Company.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.

9. Consumption: 1.28 gal. per flush.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.

D. Lever-Handle, Piston Flushometer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. American Standard.
  - ii. Kohler Co.
  - iii. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Consumption: 1.28 gal. per flush.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.

E. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. American Standard.
  - ii. Delany Products.
  - iii. Gerber Plumbing Fixtures LLC.
  - iv. Hydrotek International, Inc.
  - v. Kohler Co.
  - vi. Moen Incorporated.
  - vii. Sloan Valve Company.
  - viii. Stern Engineering Ltd.
  - ix. TOTO USA, INC.
  - x. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.

8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Consumption: 1.28 gal. per flush.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

## 2.03 TOILET SEATS

### A. Toilet Seats: Refer to Fixture Schedule on P002.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Bemis Manufacturing Company.
  - ii. Kohler Co.
  - iii. Olsonite Seat Co.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

## 2.04 SUPPORTS

### A. Water Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - i. Zurn Industries, LLC.
  - ii. JR Smith
2. Standard: ASME A112.6.1M.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

## 2.05 WALL-HUNG URINALS

### A. Urinals: Wall hung, back outlet, blowout.

1. Manufactures:
  - i. Kohler Co.

- ii. Zurn Industries, LLC.
    - iii. American Standard
    - iv.
  - 2. Fixture:
    - i. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - ii. Material: Vitreous china.
    - iii. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
    - iv. Water Consumption: Water saving.
    - v. Spud Size and Location: NPS 1-1/4; top.
    - vi. Outlet Size and Location: NPS 2; back.
    - vii. Color: White.
  - 3. Flushometer Valve: Refer to Fixture Schedule on P002.
  - 4. Waste Fitting:
    - i. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    - ii. Size: NPS 2.
  - 5. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights..
  - 6. Urinal Mounting Height: Refer to Fixture Schedule on P002.
- B. Urinals: Wall hung, back outlet, siphon jet, accessible.
- 1. Manufactures:
    - i. Kohler Co.
    - ii. Zurn Industries, LLC.
    - iii. American Standard
  - 2. Fixture:
    - i. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - ii. Material: Vitreous china.
    - iii. Type: Siphon jet.
    - iv. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
    - v. Water Consumption: Low.
    - vi. Spud Size and Location: NPS 3/4; top.
    - vii. Outlet Size and Location: NPS 2; back.
    - viii. Color: White.
  - 3. Flushometer Valve: Refer to Fixture Schedule on P002.
  - 4. Waste Fitting:
    - i. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    - ii. Size: NPS 2.
  - 5. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights..

6. Urinal Mounting Height: Refer to Fixture Schedule on P002.
- C. Urinals: Wall hung, back outlet, washout, accessible.
  1. Manufactures:
    - i. Kohler Co.
    - ii. Zurn Industries, LLC.
    - iii. American Standard
  2. Fixture:
    - i. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - ii. Material: Vitreous china.
    - iii. Type: Washout with extended shields.
    - iv. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
    - v. Water Consumption: Low.
    - vi. Spud Size and Location: NPS 3/4, top.
    - vii. Outlet Size and Location: NPS 2, back.
    - viii. Color: White.
  3. Flushometer Valve: Refer to Fixture Schedule on P002.
  4. Waste Fitting:
    - i. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    - ii. Size: NPS 2.
  5. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
  6. Urinal Mounting Height: Refer to Fixture Schedule on P002.

## 2.06 URINAL FLUSHOMETER VALVES

### A. Lever-Handle, Diaphragm Flushometer Valves:

1. Manufactures:
  - i. Sloan Valve Company
  - ii. Zurn Industries, LLC.
  - iii. American Standard
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Consumption: 0.125 gal. per flush.
10. Minimum Inlet: NPS 3/4.



11. Minimum Outlet: NPS 1-1/4.

B. Solenoid-Actuator, Diaphragm Flushometer Valves:

1. Manufactures:

- i. Sloan Valve Company
- ii. Zurn Industries, LLC.
- iii. American Standard

2. Standard: ASSE 1037.

3. Minimum Pressure Rating: 125 psig.

4. Features: Include integral check stop and backflow-prevention device.

5. Material: Brass body with corrosion-resistant components.

6. Exposed Flushometer-Valve Finish: Chrome plated.

7. Panel Finish: Chrome plated or stainless steel.

8. Style: Exposed.

9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.

10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.

11. Consumption: 0.125 gal. per flush.

12. Minimum Inlet: NPS 3/4.

13. Minimum Outlet: NPS 1-1/4.

C. Lever-Handle, Piston Flushometer Valves: Refer to Fixture Schedule on P002.

1. Manufactures:

- i. Sloan Valve Company
- ii. Zurn Industries, LLC.
- iii. American Standard

2.

3. Standard: ASSE 1037.

4. Minimum Pressure Rating: 125 psig.

5. Features: Include integral check stop and backflow-prevention device.

6. Material: Brass body with corrosion-resistant components.

7. Exposed Flushometer-Valve Finish: Chrome plated.

8. Panel Finish: Chrome plated or stainless steel.

9. Style: Exposed.

10. Consumption: 0.125 gal. per flush.

11. Minimum Inlet: NPS 3/4.

12. Minimum Outlet: NPS 1-1/4.

D. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves:

1. Manufactures:
  - i. Sloan Valve Company
  - ii. Zurn Industries, LLC.
  - iii. American Standard
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
11. Consumption: 0.125 gal. per flush.
12. Minimum Inlet: NPS 3/4.
13. Minimum Outlet: NPS 1-1/4.

## 2.07 SUPPORTS

- A. Type I Urinal Carrier:
  1. Standard: ASME A112.6.1M.
- B. Type II Urinal Carrier:
  1. Standard: ASME A112.6.1M.
- C. Type I Sink Carrier:
  1. Standard: ASME A112.6.1M.

## 1.1 LAVATORIES:

### 2.08 ENAMELED, CAST-IRON, COUNTER-MOUNTED LAVATORIES

- A. Lavatory: Rectangular, flat rim, enameled, cast iron, flush counter mounted.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Commercial Enameling Company.
    - ii. Kohler Co.
  2. Fixture:
    - i. Standard: ASME A112.19.1/CSA B45.2.
    - ii. Type: For flush mounting with kit.
    - iii. Nominal Size: Rectangular, Refer to Fixture Schedule on P002.

- iv. Faucet-Hole Punching: Refer to Fixture Schedule on P002..
    - v. Faucet-Hole Location: Top.
    - vi. Color: White.
    - vii. Mounting Materials: With stainless-steel ring, and sealant.
  - 3. Faucet: Refer to Fixture Schedule on P002.
- B. Lavatory: Oval, self-rimming, enameled, cast iron, counter mounted. Refer to Fixture Schedule on P002.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Kohler Co.
    - ii. Zurn Industries, LLC.
    - iii. American Standard
  - 2. Fixture:
    - i. Standard: ASME A112.19.1/CSA B45.2.
    - ii. Type: Self-rimming for above-counter mounting.
    - iii. Nominal Size: Refer to Fixture Schedule on P002.
    - iv. Faucet-Hole Punching: Refer to Fixture Schedule on P002.
    - v. Faucet-Hole Location: Top.
    - vi. Color: White.
    - vii. Mounting Material: Sealant.
  - 3. Faucet: Refer to Fixture Schedule on P002.
- C. Lavatory: Oval, enameled, cast iron, undercounter mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - i. Kohler Co.
  - 2. Fixture:
    - i. Standard: ASME A112.19.1/CSA B45.2.
    - ii. Type: For undercounter mounting.
    - iii. Nominal Size: Oval, 24 by 18 inches.
    - iv. Faucet-Hole Punching: No holes.
    - v. Faucet-Hole Location: On countertop.
    - vi. Color: White.
    - vii. Mounting Materials: Sealant and undercounter mounting kit.
  - 3. Faucet: Refer to Fixture Schedule on P002.

2.09 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory: Rectangular, self-rimming, vitreous china, counter mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. American Standard.
    - ii. Kohler Co.
    - iii. TOTO USA, INC.
  - 2. Fixture:
    - i. Standard: ASME A112.19.2/CSA B45.1.
    - ii. Type: Self-rimming for above-counter mounting.
    - iii. Nominal Size: Rectangular, Refer to Fixture Schedule on P002.
    - iv. Faucet-Hole Punching: Refer to Fixture Schedule on P002.
    - v. Faucet-Hole Location: Top.
    - vi. Color: White.
    - vii. Mounting Material: Sealant.
  - 3. Faucet: Refer to Fixture Schedule on P002.
- B. Lavatory: Self-rimming, vitreous china, counter mounted. Refer to Fixture Schedule on P002.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. American Standard.
    - ii. Kohler Co.
    - iii. Zurn Industries, LLC.
  - 2. Fixture:
    - i. Standard: ASME A112.19.2/CSA B45.1.
    - ii. Type: Self-rimming for above-counter mounting.
    - iii. Nominal Size: Oval, Refer to Fixture Schedule on P002.
    - iv. Nominal Size: Round, Refer to Fixture Schedule on P002.
    - v. Faucet-Hole Punching: Refer to Fixture Schedule on P002.
    - vi. Faucet-Hole Location: Top.
    - vii. Color: White.
    - viii. Mounting Material: Sealant.
  - 3. Faucet: Refer to Fixture Schedule on P002.
- C. Lavatory: Oval, vitreous china, undercounter mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. American Standard.
    - ii. Capizzi.
    - iii. Crane Plumbing, L.L.C.
    - iv. FNW; Ferguson Enterprises, Inc.
    - v. Gerber Plumbing Fixtures LLC.
    - vi. Kohler Co.
    - vii. Mansfield Plumbing Products LLC.

- viii. Peerless Pottery Sales, Inc.
- ix. Sloan Valve Company.
- x. TOTO USA, INC.
- xi. Zurn Industries, LLC.

2. Fixture:

- i. Standard: ASME A112.19.2/CSA B45.1.
- ii. Type: For undercounter mounting.
- iii. Nominal Size: Oval, Refer to Fixture Schedule on P002.
- iv. Faucet-Hole Punching: No holes.
- v. Faucet-Hole Location: On countertop.
- vi. Color: White.
- vii. Mounting Material: Sealant and undercounter mounting kit.

3. Faucet: Refer to Fixture Schedule on P002.

2.10 ENAMELED, CAST-IRON, WALL-MOUNTED LAVATORIES

A. Lavatory: Rectangular, enameled, cast iron, wall mounted.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. American Standard.
  - ii. Kohler Co.
  - iii. Zurn Industries, LLC.
- 2. Fixture:
  - i. Standard: ASME A112.19.1/CSA B45.2.
  - ii. Type: Straight-front apron with straight back.
  - iii. Nominal Size: Rectangular, Refer to Fixture Schedule on P002.
  - iv. Faucet-Hole Punching: Refer to Fixture Schedule on P002.
  - v. Faucet-Hole Location: Top.
  - vi. Color: White.
  - vii. Mounting Material: Wall bracket.
- 3. Faucet: Refer to Fixture Schedule on P002.
- 4. Support: Type III lavatory carrier. Include rectangular, steel uprights.
- 5. Lavatory Mounting Height: Refer to Fixture Schedule on P002.

B. Lavatory: Corner, enameled, cast iron, wall mounted.

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - i. Kohler Co.
- 2. Fixture:
  - i. Standard: ASME A112.19.1/CSA B45.2.
  - ii. Type: Three-sided-front apron with three-sided back.

- iii. Nominal Size: Corner, 11 by 11 inches.
- iv. Faucet-Hole Punching: Three holes, 2-inch centers.
- v. Faucet-Hole Location: Top.
- vi. Color: White.
- vii. Mounting Material: Wall brackets.
- 3. Faucet: Manufacturer's standard; factory installed.
- 4. Support: Type III lavatory carrier with two hanger plates made for corner lavatories. Include rectangular, steel uprights.
- 5. Lavatory Mounting Height: Refer to Fixture Schedule on P002.

## 2.11 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

### A. Lavatory: Vitreous china, wall mounted, with back.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. American Standard.
  - ii. Kohler Co.
  - iii. Zurn Industries, LLC.
- 2. Fixture:
  - i. Standard: ASME A112.19.2/CSA B45.1.
  - ii. Type: For wall hanging.
  - iii. Nominal Size: Oval, Refer to Fixture Schedule on P002.
  - iv. Faucet-Hole Punching: Refer to Fixture Schedule on P002.
  - v. Faucet-Hole Location: Top.
  - vi. Color: White.
  - vii. Mounting Material: Chair carrier.
- 3. Faucet: Refer to Fixture Schedule on P002.
- 4. Support: Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.
- 5. Lavatory Mounting Height: Refer to Fixture Schedule on P002.

### B. Lavatory: Ledge back, vitreous china, wall mounted.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. American Standard.
  - ii. Kohler Co.
  - iii. Sloan Valve Company.
- 2. Fixture:
  - i. Standard: ASME A112.19.2/CSA B45.1.
  - ii. Type: For wall hanging.
  - iii. Nominal Size: Oval, Refer to Fixture Schedule on P002.
  - iv. Faucet-Hole Punching: Refer to Fixture Schedule on P002.

- v. Faucet-Hole Location: Top.
    - vi. Color: White.
    - vii. Mounting Material: Chair carrier.
  - 3. Faucet: Refer to Fixture Schedule on P002.
  - 4. Support: Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.
  - 5. Lavatory Mounting Height: Refer to Fixture Schedule on P002.
- C. Lavatory: Slab type, vitreous china, wall mounted. Refer to Fixture Schedule on P002.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. American Standard.
    - ii. Gerber Plumbing Fixtures LLC.
    - iii. Kohler Co.
    - iv. Zurn Industries, LLC.
  - 2. Fixture:
    - i. Standard: ASME A112.19.2/CSA B45.1.
    - ii. Type: For wall hanging.
    - iii. Nominal Size: Oval, Refer to Fixture Schedule on P002.
    - iv. Faucet-Hole Punching: Refer to Fixture Schedule on P002.
    - v. Faucet-Hole Location: Top.
    - vi. Color: White.
    - vii. Mounting Material: Chair carrier.
  - 3. Faucet: Refer to Fixture Schedule on P002.
  - 4. Support: Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights..
  - 5. Lavatory Mounting Height: Refer to Fixture Schedule on P002.
- D. Lavatory: Wheelchair, vitreous china, wall mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. American Standard.
    - ii. Kohler Co.
    - iii. Zurn Industries, LLC.
  - 2. Fixture:
    - i. Standard: ASME A112.19.2/CSA B45.1.
    - ii. Type: Slab or wheelchair.
    - iii. Nominal Size: Rectangular, 27 by 20 inches.
    - iv. Faucet-Hole Punching: Three holes, 2-inch centers.
    - v. Faucet-Hole Location: Top.
    - vi. Color: White.
    - vii. Mounting: For concealed-arm carrier.

3. Faucet: Refer to Fixture Schedule on P002.
4. Support: Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.
5. Lavatory Mounting Height: Handicapped/elderly according to ICC A117.1.

#### 2.12 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets: Automatic-type, battery-powered, electronic-sensor-operated, mixing, solid-brass valve.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Chicago Faucets; Geberit Company.
    - ii. Sloan Valve Company.
    - iii. Zurn Industries, LLC.
  2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
  3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
  5. Body Type: Single hole.
  6. Body Material: Commercial, solid brass.
  7. Finish: Polished chrome plate.
  8. Maximum Flow Rate: 1.5 gpm.
  9. Mounting Type: Deck, concealed.
  10. Spout: Rigid type.
  11. Spout Outlet: Aerator.
  12. Drain: Refer to Fixture Schedule on P002.

#### 2.13 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout-outlet materials that will be in contact with potable water.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. AM Conservation Group, Inc.
  2. Chronomite Laboratories, Inc.
  3. NEOPERL, Inc.
  4. T&S Brass and Bronze Works, Inc.
- C. Description: Chrome-plated-brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.



#### 2.14 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
  - 1. NPS 1/2.
  - 2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

#### 2.15 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
  - 1. Size: NPS 1-1/2 by NPS 1-1/4.
  - 2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.
  - 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

#### 2.16 SUPPORTS

- A. Type II Lavatory Carrier:
  - 1. Standard: ASME A112.6.1M.
- B. Type III Lavatory Carrier:
  - 1. Standard: ASME A112.6.1M.

#### 2.17 SINK FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets: Manual type, mixing valve. Refer to Fixture Schedule on P002.
  - 1. Commercial, Solid-Brass Faucets:
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Chicago Faucets; Geberit Company.
      - 2) Sloan Valve Company.
      - 3) T&S Brass and Bronze Works, Inc.
  - 2. General-Duty, Solid-Brass Faucets:
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Chicago Faucets; Geberit Company.

- 2) Kohler Co.
  - 3) T&S Brass and Bronze Works, Inc.
- C. Sink Faucets: Automatic, sensor-operated type, battery-powered, mixing valve.
1. Commercial, Solid-Brass Faucets:
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Chicago Faucets; Geberit Company.
      - 2) Sloan Valve Company.
      - 3) T&S Brass and Bronze Works, Inc.
  2. General-Duty, Solid-Brass Faucets:
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Chicago Faucets; Geberit Company.
      - 2) Kohler Co.
      - 3) T&S Brass and Bronze Works, Inc.
  3. Standard: ASME A112.18.1/CSA B125.1.
  4. General: Coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
  5. Body Type: Refer to Fixture Schedule on P002.
  6. Body Material: Refer to Fixture Schedule on P002.
  7. Finish: Polished chrome plate.
  8. Maximum Flow Rate: 1.5 gpm.
  9. Mounting Type: Deck.
  10. Spout Type: Refer to Fixture Schedule on P002.
  11. Spout Outlet: Refer to Fixture Schedule on P002.
  12. Thermostatic Mixing Valve: Below deck, with check valves.
  13. Control module: Below deck, water-resistant module with internal flow setting switches.

## 2.18 SUPPORTS

### A. Type II Sink Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. Josam Company.
  - iii. MIFAB, Inc.
2. Standard: ASME A112.6.1M.

## 2.19 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.

- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
  - 1. NPS 1/2.
  - 2. Chrome-plated, rigid-copper pipe Chrome-plated, soft-copper flexible tube.

## 2.20 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
  - 1. Size: NPS 1-1/2.
  - 2. Material: Chrome-plated,; and chrome-plated brass or steel wall flange.
  - 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

## 2.21 GROUT

- A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

# **PART 3 - EXECUTION**

## 3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.02 INSTALLATION

- A. Water-Closet Installation:
  - 1. Install level and plumb according to roughing-in drawings.
  - 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
  - 3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
- B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

### 3.03 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

### 3.04 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### 3.05 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.
- D. Fixtures shall be protected during construction from any damages. Refinished fixtures will not be acceptable under any conditions.

**END OF SECTION**

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## SECTION 22 47 13

### DRINKING FOUNTAINS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes drinking fountains and related components.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 220000 "General Plumbing Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken"
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- B. Product Data: For each type of drinking fountain.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, and furnished specialties and accessories.

- C. Sustainable Design Submittals:

1. Product Data: For water consumption.

##### 1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For drinking fountains to include in maintenance manuals.

#### PART 2 - PRODUCTS

##### 2.01 DRINKING FOUNTAINS

- A. Cast-Iron or Steel Drinking Fountains:

- i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Belson Outdoors, Inc.
- 2) Halsey Taylor.
- 3) Haws Corporation.
- 4) Murdock Manufacturing; A Member of Morris Group International.
- 5) Stern-Williams Co., Inc.

2. Standards: Comply with ICC A117.1 and NSF 61 Annex G.

3. Receptor(s):

- i. Material: Chrome-plated brass or stainless steel.
  - ii. Shape: Rounded front.
  - iii. Bubbler: One for each receptor, with adjustable stream regulator.
  - iv. Drain: Grid type with NPS 1-1/4 tailpiece.
- 4. Maximum water flow: 0.15 gpm.
- 5. Controls: Push button.
- 6. Access to Internal Components: Panel in pedestal.
- 7. Supply Piping: NPS 3/8 with shutoff valve.
- 8. Drain Piping: NPS 1-1/4 minimum trap and waste.

## 2.02 SUPPORTS

### A. Type I Water Cooler Carrier:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. Josam Company.
  - iii. MIFAB, Inc.
  - iv. WATTS.
  - v. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.1M.

### B. Type II Water Cooler Carrier:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Jay R. Smith Mfg. Co.
  - ii. Josam Company.
  - iii. MIFAB, Inc.
  - iv. WATTS.
  - v. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.1M.

## **PART 3 - EXECUTION**

### 3.01 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

- B. Set pedestal drinking fountains on floor.
- C. Install recessed drinking fountains secured to wood blocking in wall construction.
- D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
- F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

### 3.03 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

### 3.04 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

### 3.05 CLEANING

- A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

**END OF SECTION**



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## SECTION 23 00 00

### GENERAL MECHANICAL REQUIREMENTS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SCOPE

- A. Basic mechanical requirements specifically applicable to Division 23 and 33 Sections.
- B. Work includes but is not necessarily limited to the following:
  - 1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:
    - i. Heating, ventilating and air conditioning systems and equipment
    - ii. Steam piping systems and equipment
    - iii. Testing, adjusting and balancing

##### 1.03 DRAWINGS AND SPECIFICATIONS

- A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a workmanlike manner.
- B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.
- C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the Owner has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the Owner's Representative.
- D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.
- E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

##### 1.04 UTILITIES

- A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given, and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

##### 1.05 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS

- A. Meet requirements of all state codes having jurisdiction.

B. State of California Code of Regulations:

1. Title 8, Industrial Relations
2. Title 19, State Fire Marshal Regulations
3. Current California Building Code (CBC), Title 24, Part 2
4. Current California Electrical Code, Title 24, Part 3
5. Current California Mechanical Code, Title 24, Part 4
6. Current California Plumbing Code, Title 24, Part 5
7. Current California Energy Code, Title 24, Part 6
8. Current California Fire Code, Title 24, Part 9
9. Current California Standards Code, Title 24, Part 12

C. Additional Referenced Standards:

1. AABC Associated Air Balance Council
2. AMCA Air Moving and Conditioning Association
3. AHRI Air-Conditioning, Heating and Refrigeration Institute
4. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
5. ASME American Society of Mechanical Engineers
6. ASTM American Society for Testing and Materials
7. NEMA National Electrical Manufacturer's Association
8. NFPA National Fire Protection Association Standards
9. PDI Plumbing and Drainage Institute
10. UL Underwriters Laboratories

D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the Owner's Representative.

E. Obtain permits, and request inspections from authority having jurisdiction.

1.06 PROJECT AND SITE CONDITIONS

- A. The arrangement of and connection to equipment shown on the Drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.
- B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.
- C. Examine site related work and surfaces before starting work of any Section.
- D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.

- E. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the Owner's Representative before proceeding.

#### 1.07 COOPERATION WITH WORK UNDER OTHER DIVISIONS

- A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
- B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.
- C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.
- D. Make such progress in the Work to not delay work of other trades.
- E. Mechanical Work shall have precedence over the other in the following sequence:
  - 1. Soil and waste piping
  - 2. Hydronic piping
  - 3. Ductwork
  - 4. Domestic water piping
  - 5. Fire sprinkler piping

#### 1.08 DISCREPANCIES

- A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify the Owner's Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.
- B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.
- C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without Owner Representative's decision. Beginning work of any Section constitutes acceptance of conditions.

#### 1.09 CHANGES

- A. The Contractor shall be responsible to make and obtain approval from the Owner's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

#### 1.10 SUBMITTALS

- A. Refer to Division 01 for additional requirements.
- B. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
- C. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
- D. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- E. Note that prior to acceptance of submittals for review, a submittal schedule shall be submitted to the Owner's Representative.
- F. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section number in one complete submittal package.
- G. Shop Drawings:
  - 1. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
  - 2. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
  - 3. If equipment is rejected, revise drawings to show acceptable equipment and resubmit.
- H. Whenever more than one (1) manufacturer's product is specified, the first named product is the basis of design used in the Drawings and the use of alternate-named manufacturer's products or substitutes may require modifications to the design.
- I. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner's Representative bearing the Owner's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the Owner's Representative without additional compensation.
- J. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
- K. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or UL, submit proof of such conformance to the Owner Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Owner Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.
- L. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
- M. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

#### 1.11 PROJECT RECORD DOCUMENTS

- A. Refer to Division 01 for additional requirements.

1. All changes, deviations and information recorded on the "Project Record Drawings" set during Construction shall be redrafted onto the latest version of Revit, where applicable.
2. Submit completed shop drawings to the Owner prior to completion in 3D AutoCAD or Revit format. Contractor hand marked or drafted redlined "Project Record Drawings" will not be accepted.

1.12 PRODUCT ALTERNATIVES OR SUBSTITUTIONS

- A. Refer to General Conditions and Division 01 for additional requirements.

1.13 OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

1.14 MANUFACTURER'S RECOMMENDATIONS

- A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.15 DELIVERY AND STORAGE

- A. Refer to Division 01 for additional requirements.
- B. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

1.16 GUARANTEE

- A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.
- B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner for their service agency as directed.

**PART 2 - PRODUCTS**

- A. Not Applicable.

**PART 3 - EXECUTION**

3.01 GENERAL

- A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the Owner's Representative.

3.02 WORK RESPONSIBILITIES

- A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.

- B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.
- C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.
- D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.
- F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the Owner immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the Owner.
- G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Owner and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.
- H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.
- I. Replace or repair, without additional compensation, any Work, which, in the opinion of the Owner, does not comply with these requirements.

**END OF SECTION**

## SECTION 23 05 19

### METERS AND GAUGES FOR HVAC PIPING

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Thermowells
2. Test plugs
3. Test-plug kits

###### B. Related Requirements:

1. Section 232113 "Hydronic Piping"
2. Section 232116 "Hydronic Piping Specialties"

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- B. Product Data: For each type of product indicated.

- C. Schedule: For thermometers, pressure gauges, thermowell and test plugs indicating manufacturer's number, scale range, and location for each.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gauge from manufacturer.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

#### **PART 2 - PRODUCTS**

##### 2.01 THERMOWELLS

###### A. Manufacturers:

1. Ashcroft Commercial Inc.
2. Marsh Bellofram.
3. Terice, H. O. Co.



4. Weiss Instruments, Inc.
5. 3D Instruments
6. Or equal.

B. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping.
3. Pressure Rating: Not less than piping system design pressure.
4. Material: stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPT 1/2, NPT 3/4, or NPT 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Extend one-third to two-thirds of pipe diameter into fluid.
10. Lagging Extension: Extension for Insulated Piping: 2 inches nominal and not less than thickness of insulation.
11. Bushings: are prohibited.

C. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.02 TEST PLUGS

A. Manufacturers:

1. Peterson Equipment Co., Inc.
2. Sisco Manufacturing Co.
3. IMI Hydronic Engineering (Flow Design), Inc.
4. Or equal.

B. Description: Corrosion-resistant brass or stainless-steel body with minimum two core inserts and gasketed and threaded cap with cap retainer, with extended stem beyond insulation for units to be installed in insulated piping.

C. Thread Size: NPT 1/2, ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

E. Core Inserts: Two chlorosulfonated (CR) polyethylene synthetic and EPDM (Nordel) self-sealing rubber, valves gasketed orifice, suitable for inserting a 1/8" OD probe assembly.

1. Insert material for air, water (except for water heated by high temperature water), oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or high temperature water heated hot water service at 30 to plus 275 deg F shall be EPDM.

F. If test plug requires probes longer than 1-inch, provide to the Owner three probes of the required length for the installed test plug.

2.03 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Peterson Equipment Co., Inc.

2. Sisco Manufacturing Co.
  3. IMI Hydronic Engineering (Flow Design), Inc.
  4. Or equal.
- B. Furnish **one** test-plug kit containing two thermometers, one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- D. High-Range Thermometer: Small, bimetallic insertion type with 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- E. Pressure Gauge: Small, Bourdon-tube insertion type with 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION**

- A. Install thermowells with socket extending a minimum of 2 inches into fluid or to the center of pipe and in vertical position in piping tees where thermometers are indicated.
- B. Install thermowells with extension on insulated piping.
- C. Fill thermowells with heat-transfer medium.
- D. Install test plugs in tees in piping.

**END OF SECTION**

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## SECTION 23 05 23.12

### **BALL VALVES FOR HVAC PIPING**

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:

- 1. Bronze ball valves.

##### 1.03 DEFINITIONS

- A. CWP: Cold working pressure.
- B. SWP: Steam working pressure.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

- 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- B. Product Data: For each type of valve.

##### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

- 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and weld ends.
  - 3. Set ball valves open to minimize exposure of functional surfaces.

- B. Use the following precautions during storage:

- 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

#### **PART 2 - PRODUCTS**

##### 2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
  2. ASME B16.1 for flanges on iron valves.
  3. ASME B16.5 for flanges on steel valves.
  4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  5. ASME B16.18 for solder-joint connections.
  6. ASME B31.1 for power piping valves.
  7. ASME B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Refer to HVAC valve schedule articles for applications of valves.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
1. Include 2-inch stem extensions.
  2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
  3. Memory stops that are fully adjustable after insulation is applied.
- I. Valve Bypass and Drain Connections: MSS SP-45.

## 2.02 BRONZE BALL VALVES

### A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Manufacturers:
  - i. NIBCO Figure T-585-70-66
  - ii. Milwaukee Valve Figure BA400S.
  - iii. Conbraco Industries, Inc; Apollo Division Figure 77-140.
2. Description:
  - i. Standard: MSS SP-110.
  - ii. SWP Rating: 150 psig.
  - iii. CWP Rating: 600 psig.
  - iv. Body Design: Two piece.
  - v. Body Material: Bronze.
  - vi. Ends: Threaded.
  - vii. Seats: PTFE.
  - viii. Stem: Stainless steel.
  - ix. Ball: Stainless steel, vented.
  - x. Port: Full.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### **3.02 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

### **3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS**

- A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

### **3.04 CHILLED-WATER VALVE SCHEDULE**

- A. Pipe NPS 2 and Smaller: Bronze ball valves, two-piece, with stainless-steel trim, extended stem or thermal insulating tee handle to allow vapor barrier piping insulation, full port, threaded ends.

### **3.05 HEATING-WATER VALVE SCHEDULE**

- A. Pipe NPS 2 and Smaller: Bronze ball valves, two-piece, with stainless-steel trim, full port, threaded.

**END OF SECTION**

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## SECTION 23 05 29

### HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.

###### B. Related Sections:

1. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
2. Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts" for duct hangers and supports.

##### 1.03 REFERENCES

- A. ASME B31.9 Building Services Piping
- B. MSS SP58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application and installation
- C. MSS SP-69 Pipe Hangers and Supports – Selection and Application
- D. MSS SP-89 Pipe Hangers and Supports – Fabrication and Installation Practices

##### 1.04 DEFINITIONS

- A. ASCE: American Society of Civil Engineers
- B. ASME: American Society of Mechanical Engineers
- C. ASTM: American Society for Testing and Material
- D. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.
- E. MFMA: Metal Framing Manufacturers Association
- F. SEI: Structural Engineering Institute

##### 1.05 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to Standard ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.



1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

#### 1.06 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  1. "No Exception Taken".
  2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product indicated including component cut sheets and pre-approved details.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
  1. Trapeze pipe hangers.
  2. Metal framing systems.
  3. Pipe stands.
  4. Equipment supports.
- D. Delegated Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  1. Detail fabrication and assembly of trapeze hangers.
  2. Design Calculations: Calculate requirements for designing trapeze hangers.

#### 1.07 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.08 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to current ASME Boiler and Pressure Vessel Code.

### **PART 2 - PRODUCTS**

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

## 2.02 METAL PIPE HANGERS AND SUPPORTS

### A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

### B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

## 2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.04 METAL FRAMING SYSTEMS

### A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with in-turned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Electroplated zinc, Mill galvanized, In-line, hot galvanized or Mechanically-deposited zinc.

### B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4.

3. Channels: Continuous slotted steel channel with in-turned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of PVC coated carbon steel, hot dipped galvanized carbon steel or stainless steel.

## 2.05 VERTICAL RISER CLAMPS FOR INSULATED PIPES

### A. Vertical Riser Clamps for Insulated Copper Pipes:

1. Manufacturer shall be Hydra-Zorb Titan Riser Clamp or equal.
2. 25/50 flame spread/smoke spread index.
3. Eliminates insulation compression.
4. Crush resistant.
5. Vertical load rating up to 2400 lbs.

## 2.06 THERMAL HANGER SHIELD INSERTS

### A. Manufacturers

1. Pipe Shields Inc.
2. Pittsburg Corning Foamglas ONE
3. ITW Insulation Systems TRYMER 2000 XP

B. Cold Piping: Insulation-Insert Material - ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Hot Piping: Insulation-Insert Material - Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.07 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.08 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - i. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - ii. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

- iii. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
- 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - i. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - i. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
  - i. NPS 1/4 to NPS 3-1/2 12 inches long and 0.048 inch thick.
  - ii. NPS 4: 12 inches long and 0.06 inch thick.
  - iii. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
  - iv. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
  - v. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.02 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.03 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.04 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Copper Pipe or Tubing
  - 1. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

2. Or use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
  6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  9. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  10. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of non-insulated pipe risers NPS 3/4 to NPS 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of non-insulated pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
  3. Insulated piping shall use vertical riser clamps for insulated pipe.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment, up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - i. Light (MSS Type 31): 750 lb.
    - ii. Medium (MSS Type 32): 1500 lb.
    - iii. Heavy (MSS Type 33): 3000 lb.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - i. Horizontal (MSS Type 54): Mounted horizontally.
    - ii. Vertical (MSS Type 55): Mounted vertically.
    - iii. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

**END OF SECTION**



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## SECTION 23 05 53

### IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Valve tags.
  - 5. Warning tags.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

##### 1.04 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

#### **PART 2 - PRODUCTS**

##### 2.01 GENERAL

- A. Manufacturers:
  - 1. Craftmark Identification Systems
  - 2. Seton Identification Products

3. MSI Marking Services

4. Setmark

## 2.02 EQUIPMENT LABELS

### A. Plastic Labels for Equipment:

1. Material and Thickness: Three-layer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick and having predrilled holes for attachment hardware.

2. Color Coding:

i. Letter Color: White.

ii. Background Color: Black.

3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.03 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Color Coding:

1. Background Color: Yellow.

2. Letter Color: Black.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.04 PIPE LABELS

- A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pre-tensioned Pipe Labels for Outside Diameter Less or Equal to 8 Inches: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels for Outside Diameter Greater than 8 Inches: Printed plastic with contact-type, permanent-adhesive backing. Either marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

## 2.05 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2 inch sequenced numbers.
  - 1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2 by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve tag schedule shall be included in operation and maintenance data.

## 2.06 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size: Approximately 4 by 7 inches.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption such as "DANGER", "CAUTION" or "DO NOT OPERATE."
  - 4. Color:
    - i. Background Color: Yellow.
    - ii. Letter Color: Black.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### **3.02 GENERAL INSTALLATION REQUIREMENTS**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

### **3.03 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### **3.04 PIPE LABEL INSTALLATION**

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Within one foot of each valve and control device.
  - 2. Near each branch connection and riser takeoff.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. Near major equipment items and other points of origination and termination.
  - 5. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 6. Spaced at maximum intervals of 20 feet along each run, but not less than once in each room at entrance and exit of each concealed space.
  - 7. On piping above removable acoustical ceilings.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
  - 1. Chilled-Water Piping:
    - i. Background Color: Green.
    - ii. Letter Color: White.
  - 2. Heating Water Piping:
    - i. Background Color: Yellow.
    - ii. Letter Color: Black.
  - 3. Refrigerant Piping:
    - i. Background Color: Yellow.
    - ii. Letter Color: Black.

### 3.05 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except valves within factory-fabricated equipment units; faucets; convenience and lawn-watering hose connections. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:
    - i. Chilled Water: 2 inches, round.
    - ii. Hot Water: 2 inches, round.
    - iii. Refrigerant: 2 inches, round.
  - 2. Valve-Tag Color:
    - i. Chilled Water: Natural.
    - ii. Hot Water: Natural.
    - iii. Refrigerant: Natural.
  - 3. Letter Color:
    - i. Chilled Water: Black.
    - ii. Hot Water: Black.
    - iii. Refrigerant: Black.
- C. All above and below grade and interior and exterior valves shall be tagged. Submit valve tag chart to the Owner Representative for review and approval at the completion of the project.

### 3.06 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

**END OF SECTION**

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## SECTION 23 05 93

### TESTING, ADJUSTING, AND BALANCING FOR HVAC

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Balancing Air Systems:
  - i. Constant-volume air systems.
  - ii. Variable-air-volume systems.
2. Balancing Hydronic Piping Systems:
  - i. Variable-flow hydronic systems.
  - ii. Primary-secondary hydronic systems.
3. Testing, Adjusting, and Balancing Equipment:
  - i. Motors.
  - ii. Chillers.
  - iii. Condensing units.
  - iv. Boilers.
  - v. Heat-transfer coils.
  - vi. Pumps
4. Testing, adjusting, and balancing existing systems and equipment.
5. Duct leakage tests.
6. Control system verification.

##### 1.03 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All



**exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  1. Instrument type and make.
  2. Serial number.
  3. Application.
  4. Dates of use.
  5. Dates of calibration.

#### 1.06 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Engage an independent TAB Contractor certified by AABC, NEBB or TABB.
  1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB or TABB.
  2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

### **PART 2 - PRODUCTS (NOT APPLICABLE)**

### **PART 3 - EXECUTION**

#### 3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify

that locations of these balancing devices are applicable for intended purpose and are accessible.

- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

- i. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
- ii. Duct systems are complete with terminals installed.
- iii. Volume, smoke, and fire dampers are open and functional.
- iv. Clean filters are installed.
- v. Fans are operating, free of vibration, and rotating in correct direction.
- vi. Variable-frequency controllers' startup is complete and safeties are verified.
- vii. Automatic temperature-control systems are operational.
- viii. Ceilings are installed.
- ix. Windows and doors are installed.
- x. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

- i. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
- ii. Piping is complete with terminals installed.
- iii. Water treatment is complete.
- iv. Systems are flushed, filled, and air purged.
- v. Strainers are pulled and cleaned.
- vi. Control valves are functioning per the sequence of operation.
- vii. Shutoff and balance valves have been verified to be 100 percent open.
- viii. Pumps are started and proper rotation is verified.
- ix. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- x. Variable-frequency controllers' startup is complete and safeties are verified.
- xi. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- C. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - i. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    - ii. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    - iii. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    - iv. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
  - 2. Measure fan static pressures as follows:
    - i. Measure static pressure directly at the fan outlet or through the flexible connection.
    - ii. Measure static pressure directly at the fan inlet or through the flexible connection.
    - iii. Measure static pressure across each component that makes up the air-handling system.
    - iv. Report artificial loading of filters at the time static pressures are measured.
  - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 4. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for

adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
  2. Adjust submain and branch duct volume dampers for specified airflow.
  3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  2. Measure inlets and outlets airflow.
  3. Adjust each inlet and outlet for specified airflow.
  4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
  2. Re-measure and confirm that total airflow is within design.
  3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
  4. Mark all final settings.
  5. Test system in economizer mode. Verify proper operation and adjust if necessary.
  6. Measure and record all operating data.
  7. Record final fan-performance data.

### 3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located at least two-thirds of the distance down the duct from the fan discharge or as shown on the Drawings.
  2. Verify that the system is under static pressure control.
  3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
  4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
    - i. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.

- ii. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
  - iii. When maximum airflow is correct, balance the air outlets downstream from terminal units.
  - iv. Adjust controls so that terminal is calling for minimum airflow.
  - v. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
  - vi. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
- i. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
  - ii. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
  - iii. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
  - iv. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - v. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
- i. Measure static pressure directly at the fan outlet or through the flexible connection.
  - ii. Measure static pressure directly at the fan inlet or through the flexible connection.
  - iii. Measure static pressure across each component that makes up the air-handling system.
  - iv. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
- i. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
  - ii. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

- i. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
- ii. Re-measure and confirm that total airflow is within design.
- iii. Re-measure final fan operating data, rpms, volts, amps, and static profile.
- iv. Mark final settings.
- v. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
- vi. Verify tracking between supply and return fans.
- vii. Verify building pressurization control by measuring building pressure at various operating conditions.

### 3.07 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
  - 1. Check liquid level in expansion tank.
  - 2. Check highest vent for adequate pressure.
  - 3. Check flow-control valves for proper position.
  - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
  - 5. Verify that motor starters are equipped with properly sized thermal protection.
  - 6. Check that air has been purged from the system.

### 3.08 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above in General Procedures for Hydronic Systems.
- B. Adjust the variable-flow hydronic system as follows:
  - 1. Verify that the differential-pressure sensor is located as indicated.
  - 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
  - 1. Adjust pumps to deliver total design gpm.
    - i. Measure total water flow.
      - 1) Position valves for full flow through coils.
      - 2) Measure flow by main flow meter, if installed.
      - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
    - ii. Measure pump TDH as follows:
      - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.

- 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - 3) Convert pressure to head and correct for differences in gage heights.
    - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
  - iii. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
  - i. Measure flow in main and branch pipes.
  - ii. Adjust main and branch balance valves for design flow.
  - iii. Re-measure each main and branch after all have been adjusted.
3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
  - i. Measure flow at terminals.
  - ii. Adjust each terminal to design flow.
  - iii. Re-measure each terminal after it is adjusted.
  - iv. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
  - v. Perform temperature tests after flows have been balanced.
4. For systems with pressure-independent valves at terminals:
  - i. Measure differential pressure and verify that it is within manufacturer's specified range.
  - ii. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
  - i. Measure and balance coils by either coil pressure drop or temperature method.
  - ii. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
  - i. Re-measure and confirm that total water flow is within design.



- ii. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
  - iii. Mark final settings.
- 10. Verify that memory stops have been set.
- D. For systems with diversity:
  - 1. Determine diversity factor.
  - 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
  - 3. Adjust pumps to deliver total design gpm.
    - i. Measure total water flow.
      - 1) Position valves for full flow through coils.
      - 2) Measure flow by main flow meter, if installed.
      - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
    - ii. Measure pump TDH as follows:
      - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      - 3) Convert pressure to head and correct for differences in gage heights.
      - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
    - iii. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
  - 4. Adjust flow-measuring devices installed in mains and branches to design water flows.
    - i. Measure flow in main and branch pipes.
    - ii. Adjust main and branch balance valves for design flow.
    - iii. Re-measure each main and branch after all have been adjusted.
  - 5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    - i. Measure flow at terminals.
    - ii. Adjust each terminal to design flow.
    - iii. Re-measure each terminal after it is adjusted.
    - iv. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    - v. Perform temperature tests after flows have been balanced.
  - 6. For systems with pressure-independent valves at terminals:

- i. Measure differential pressure, and verify that it is within manufacturer's specified range.
  - ii. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
  - i. Measure and balance coils by either coil pressure drop or temperature method.
  - ii. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
  - i. Re-measure and confirm that total water flow is within design.
  - ii. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
  - iii. Mark final settings.
13. Verify that memory stops have been set.

### 3.09 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first.
- B. Balance the secondary circuits after the primary circuits are complete.
- C. Adjust pumps to deliver total design gpm.
  1. Measure total water flow.
    - i. Position valves for full flow through coils.
    - ii. Measure flow by main flow meter, if installed.
    - iii. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
  2. Measure pump TDH as follows:
    - i. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    - ii. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - iii. Convert pressure to head and correct for differences in gage heights.

- iv. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - v. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
  3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- D. Adjust flow-measuring devices installed in mains and branches to design water flows.
  1. Measure flow in main and branch pipes.
  2. Adjust main and branch balance valves for design flow.
  3. Re-measure each main and branch after all have been adjusted.
- E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
  1. Measure flow at terminals.
  2. Adjust each terminal to design flow.
  3. Re-measure each terminal after it is adjusted.
  4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
  5. Perform temperature tests after flows have been balanced.
- F. For systems with pressure-independent valves at terminals:
  1. Measure differential pressure and verify that it is within manufacturer's specified range.
  2. Perform temperature tests after flows have been verified.
- G. For systems without pressure-independent valves or flow-measuring devices at terminals:
  1. Measure and balance coils by either coil pressure drop or temperature method.
  2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- H. Verify final system conditions as follows:
  1. Re-measure and confirm that total water flow is within design.
  2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
  3. Mark final settings.
- I. Verify that memory stops have been set.

### 3.10 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  1. Manufacturer's name, model number, and serial number.
  2. Motor horsepower rating.
  3. Motor rpm.
  4. Phase and hertz.
  5. Nameplate and measured voltage, each phase.
  6. Nameplate and measured amperage, each phase.
  7. Starter size and thermal-protection-element rating.

8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

### 3.11 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
  1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
  2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
  3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
  4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
  5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
  6. Capacity: Calculate in tons of cooling.
  7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

### 3.12 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

### 3.13 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
  1. Measure and record entering- and leaving-water temperatures.
  2. Measure and record water flow.
  3. Record relief valve pressure setting.

### 3.14 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
  1. Entering- and leaving-water temperature.
  2. Water flow rate.
  3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
  4. Dry-bulb temperature of entering and leaving air.
  5. Wet-bulb temperature of entering and leaving air for cooling coils.
  6. Airflow.
- B. Measure, adjust, and record the following data for each electric heating coil:
  1. Nameplate data.
  2. Airflow.
  3. Entering- and leaving-air temperature at full load.

4. Voltage and amperage input of each phase at full load.
  5. Calculated kilowatt at full load.
  6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
  2. Airflow.
  3. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
  2. Wet-bulb temperature of entering and leaving air.
  3. Airflow.

### 3.15 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

### 3.16 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
1. Verify temperature control system is operating within the design limitations.
  2. Confirm that the sequences of operation are in compliance with Contract Documents.
  3. Verify that controllers are calibrated and function as intended.
  4. Verify that controller set points are as indicated.
  5. Verify the operation of lockout or interlock systems.
  6. Verify the operation of valve and damper actuators.
  7. Verify that controlled devices are properly installed and connected to correct controller.
  8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
  9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

### 3.17 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan.
  2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  3. Check the refrigerant charge.
  4. Check the condition of filters.
  5. Check the condition of coils.

6. Check the operation of the drain pan and condensate-drain trap.
  7. Check bearings and other lubricated parts for proper lubrication.
  8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
  2. Coils are clean and fins combed.
  3. Drain pans are clean.
  4. Fans are clean.
  5. Bearings and other parts are properly lubricated.
  6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
  2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
  3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
  4. Balance each air outlet.

### 3.18 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 percent or minus 0 percent.
  2. Air Outlets and Inlets: Plus or minus 10 percent.
  3. Heating-Water Flow Rate: Plus or minus 10 percent.
  4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.19 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems

found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.20 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
  - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  - 1. Pump curves.
  - 2. Fan curves.
  - 3. Manufacturers' test data.
  - 4. Field test reports prepared by system and equipment installers.
  - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB specialist.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - i. Indicated versus final performance.
    - ii. Notable characteristics of systems.
    - iii. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
  - 15. Test conditions for fans and pump performance forms including the following:
    - i. Settings for outdoor-, return-, and exhaust-air dampers.
    - ii. Conditions of filters.

- iii. Cooling coil, wet- and dry-bulb conditions.
  - iv. Face and bypass damper settings at coils.
  - v. Fan drive settings including settings and percentage of maximum pitch diameter.
  - vi. Inlet vane settings for variable-air-volume systems.
  - vii. Settings for supply-air, static-pressure controller.
  - viii. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
- 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.
  - 3. Duct, outlet, and inlet sizes.
  - 4. Pipe and valve sizes and locations.
  - 5. Terminal units.
  - 6. Balancing stations.
  - 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
- 1. Unit Data:
    - i. Unit identification.
    - ii. Location.
    - iii. Make and type.
    - iv. Model number and unit size.
    - v. Manufacturer's serial number.
    - vi. Unit arrangement and class.
    - vii. Discharge arrangement.
    - viii. Sheave make, size in inches, and bore.
    - ix. Center-to-center dimensions of sheave and amount of adjustments in inches.
    - x. Number, make, and size of belts.
    - xi. Number, type, and size of filters.
  - 2. Motor Data:
    - i. Motor make, and frame type and size.
    - ii. Horsepower and rpm.
    - iii. Volts, phase, and hertz.
    - iv. Full-load amperage and service factor.
    - v. Sheave make, size in inches, and bore.
    - vi. Center-to-center dimensions of sheave and amount of adjustments in inches.



3. Test Data (Indicated and Actual Values):

- i. Total airflow rate in cfm.
- ii. Total system static pressure in inches wg.
- iii. Fan rpm.
- iv. Discharge static pressure in inches wg.
- v. Filter static-pressure differential in inches wg.
- vi. Preheat-coil static-pressure differential in inches wg.
- vii. Cooling-coil static-pressure differential in inches wg.
- viii. Heating-coil static-pressure differential in inches wg.
- ix. Outdoor airflow in cfm.
- x. Return airflow in cfm.
- xi. Outdoor-air damper position.
- xii. Return-air damper position.
- xiii. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- i. System identification.
- ii. Location.
- iii. Coil type.
- iv. Number of rows.
- v. Fin spacing in fins per inch o.c.
- vi. Make and model number.
- vii. Face area in sq. ft.
- viii. Tube size in NPS.
- ix. Tube and fin materials.
- x. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- i. Airflow rate in cfm.
- ii. Average face velocity in fpm.
- iii. Air pressure drop in inches wg.
- iv. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- v. Return-air, wet- and dry-bulb temperatures in deg F.
- vi. Entering-air, wet- and dry-bulb temperatures in deg F.
- vii. Leaving-air, wet- and dry-bulb temperatures in deg F.
- viii. Water flow rate in gpm.
- ix. Water pressure differential in feet of head or psig.
- x. Entering-water temperature in deg F.

- xi. Leaving-water temperature in deg F.
  - xii. Refrigerant expansion valve and refrigerant types.
  - xiii. Refrigerant suction pressure in psig.
  - xiv. Refrigerant suction temperature in deg F.
  - xv. Inlet steam pressure in psig.
- G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
- 1. Unit Data:
    - i. System identification.
    - ii. Location.
    - iii. Make and type.
    - iv. Model number and unit size.
    - v. Manufacturer's serial number.
    - vi. Fuel type in input data.
    - vii. Output capacity in Btu/h.
    - viii. Ignition type.
    - ix. Burner-control types.
    - x. Motor horsepower and rpm.
    - xi. Motor volts, phase, and hertz.
    - xii. Motor full-load amperage and service factor.
    - xiii. Sheave make, size in inches, and bore.
    - xiv. Center-to-center dimensions of sheave and amount of adjustments in inches.
  - 2. Test Data (Indicated and Actual Values):
    - i. Total airflow rate in cfm.
    - ii. Entering-air temperature in deg F.
    - iii. Leaving-air temperature in deg F.
    - iv. Air temperature differential in deg F.
    - v. Entering-air static pressure in inches wg.
    - vi. Leaving-air static pressure in inches wg.
    - vii. Air static-pressure differential in inches wg.
    - viii. Low-fire fuel input in Btu/h.
    - ix. High-fire fuel input in Btu/h.
    - x. Manifold pressure in psig.
    - xi. High-temperature-limit setting in deg F.
    - xii. Operating set point in Btu/h.
    - xiii. Motor voltage at each connection.
    - xiv. Motor amperage for each phase.

xv. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- i. System identification.
- ii. Location.
- iii. Make and type.
- iv. Model number and size.
- v. Manufacturer's serial number.
- vi. Arrangement and class.
- vii. Sheave make, size in inches, and bore.
- viii. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

- i. Motor make, and frame type and size.
- ii. Horsepower and rpm.
- iii. Volts, phase, and hertz.
- iv. Full-load amperage and service factor.
- v. Sheave make, size in inches, and bore.
- vi. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- vii. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- i. Total airflow rate in cfm.
- ii. Total system static pressure in inches wg.
- iii. Fan rpm.
- iv. Discharge static pressure in inches wg.
- v. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- i. System and air-handling-unit number.
- ii. Location and zone.
- iii. Traverse air temperature in deg F.
- iv. Duct static pressure in inches wg.
- v. Duct size in inches.
- vi. Duct area in sq. ft.
- vii. Indicated airflow rate in cfm.
- viii. Indicated velocity in fpm.

- ix. Actual airflow rate in cfm.
- x. Actual average velocity in fpm.
- xi. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

- i. System and air-handling unit identification.
- ii. Location and zone.
- iii. Apparatus used for test.
- iv. Area served.
- v. Make.
- vi. Number from system diagram.
- vii. Type and model number.
- viii. Size.
- ix. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

- i. Airflow rate in cfm.
- ii. Air velocity in fpm.
- iii. Preliminary airflow rate as needed in cfm.
- iv. Preliminary velocity as needed in fpm.
- v. Final airflow rate in cfm.
- vi. Final velocity in fpm.
- vii. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

- i. System and air-handling-unit identification.
- ii. Location and zone.
- iii. Room or riser served.
- iv. Coil make and size.
- v. Flowmeter type.

2. Test Data (Indicated and Actual Values):

- i. Airflow rate in cfm.
- ii. Entering-water temperature in deg F.
- iii. Leaving-water temperature in deg F.
- iv. Water pressure drop in feet of head or psig.
- v. Entering-air temperature in deg F.
- vi. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

- i. Unit identification.
- ii. Location.
- iii. Service.
- iv. Make and size.
- v. Model number and serial number.
- vi. Water flow rate in gpm.
- vii. Water pressure differential in feet of head or psig.
- viii. Required net positive suction head in feet of head or psig.
- ix. Pump rpm.
- x. Impeller diameter in inches.
- xi. Motor make and frame size.
- xii. Motor horsepower and rpm.
- xiii. Voltage at each connection.
- xiv. Amperage for each phase.
- xv. Full-load amperage and service factor.
- xvi. Seal type.
- xvii. Water pressure differential across suction diffuser in feet of head or psig.

2. Test Data (Indicated and Actual Values):

- i. Static head in feet of head or psig.
- ii. Pump shutoff pressure in feet of head or psig.
- iii. Actual impeller size in inches.
- iv. Full-open flow rate in gpm.
- v. Full-open pressure in feet of head or psig.
- vi. Final discharge pressure in feet of head or psig.
- vii. Final suction pressure in feet of head or psig.
- viii. Final total pressure in feet of head or psig.
- ix. Final water flow rate in gpm.
- x. Voltage at each connection.
- xi. Amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:

- i. Instrument type and make.
- ii. Serial number.
- iii. Application.

- iv. Dates of use.
- v. Dates of calibration.

### 3.21 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.
- B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
  - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
  - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
  - 3. If the second verification also fails, Owner may contact AABC, NEBB or TABB Headquarters regarding the Performance Guaranty.
- F. Prepare test and inspection reports.

### 3.22 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

**END OF SECTION**

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## SECTION 23 07 13

### DUCT INSULATION

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Review these documents for coordination with additional requirements and information that apply to work under this Section

##### 1.02 SUMMARY

- A. Section includes insulating the following duct services:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Indoor, concealed return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
- B. Related Sections:
  - 1. Section 230719 "HVAC Piping Insulation."
  - 2. Section 233113 "Metal Ducts" for duct liners.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
  - 3. Detail application of field-applied jackets.
  - 4. Detail application at linkages of control devices.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.



1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.08 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

**PART 2 - PRODUCTS**

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. CertainTeed Corporation; SoftTouch Duct Wrap
    - ii. Johns Manville; Microlite.
    - iii. Knauf Insulation; Friendly Feel Duct Wrap.
    - iv. Owens Corning; SOFTR All-service Duct Wrap.

## 2.02 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Childers Brand; H. B. Fuller Construction Products.
    - ii. Foster Brand; H. B. Fuller
    - iii. Knauf Insulation.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- C. Vapor-Barrier Permeance: ASTM 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - i. Childers Brand; H. B. Fuller Construction Products.; CP10
    - ii. Eagle Bridges - Marathon Industries.; 550
    - iii. Foster Brand; H. B. Fuller Construction Products.; 146-50
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
  - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  - 5. Color: White.

## 2.03 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Childers Brand; H. B. Fuller Construction Products.; CP-76.
    - ii. Foster Brand; H. B. Fuller Construction Products.; 95-44.
    - iii. Mon-Eco Industries, Inc.; 44-05
    - iv. Eagle Bridges – Marathon Industries; 405.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: 20 to plus 250 deg F.
  - 5. Color: Aluminum.

6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

#### 2.04 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Childers.
  - ii. ITW Insulation Systems; Illinois Tool Works, Inc.
  - iii. RPR Products, Inc.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - i. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    - 2) ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    - 3) RPR Products, Inc.; Insul-Mate.
3. Factory cut and rolled to size.
4. Finish and thickness are indicated in field-applied jacket schedules.
  - i. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
  - ii. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.

#### 2.05 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. Compac Corporation; 110 and 111.
  - ii. ABI, Ideal Tape Division; 491 AWF FSK.
  - iii. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  - iv. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

## 2.06 SECUREMENTS

### A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - i. ITW Insulation Systems; Illinois Tool Works, Inc.; Gerrard Strapping and Seals.
  - ii. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - i. Midwest Fasteners or approved equal.
  - ii. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - iii. Spindle: Zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - iv. Adhesive-backed base with a peel-off protective cover.
5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

### B. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide product by:
  - i. C & F Wire, or equal.

## **PART 3 - EXECUTION**

### 3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - i. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### 3.04 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Section 078413 "Penetration Firestopping."
- C. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.05 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - i. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - ii. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - iii. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - iv. Do not over compress insulation during installation.
    - v. Impale insulation over pins and attach speed washers.
    - vi. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- i. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - ii. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap un-faced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.06 FIELD-APPLIED JACKET INSTALLATION

#### A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

#### B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.07 DUCT INSULATION SCHEDULE, GENERAL

#### A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air in unconditioned space.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.

#### B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with Title 24 energy code.
2. Metal ducts located in conditioned spaces.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.08 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Supply and return air duct and plenum insulation shall be the following:

1. Mineral-Fiber Blanket: 1.5 inches thick and 0.75-lb/cu. ft. nominal density.

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## SECTION 23 07 19

### HVAC PIPING INSULATION

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping.
2. Chilled-water piping.
3. Heating hot-water piping.
4. Refrigerant suction and hot-gas piping.

- B. Related Sections:

1. Section 230713 "Duct Insulation."

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance, thickness, and jackets (both factory and field applied, if any). Clearly mark the materials being provided and its intended use of each product

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports if requested by the Owner's Representative.

#### 1.05 QUALITY ASSURANCE

- A. Insulation materials shall be manufactured at facilities certified and registered with an approved registrar to conform to the ISO 9001 Quality Standard.
- B. All work shall conform to accepted industry and trade standards for commercial and industrial insulations and shall conform with manufacturer's recommendations.
- C. Installation shall be by licensed applicators.
- D. Insulation materials that have become wet or contaminated shall not be installed.
- E. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all materials (insulation, coverings, tapes, cements, adhesives, coatings, etc.) to the jobsite in factory containers with manufacturer's label showing manufacturer, product name and product hazard information.
- B. Insulation shall be delivered to the job site in original, unopened manufacturer's containers.
- C. Insulation shall be stored in a dry location and kept dry throughout construction. Wet or damaged insulation shall be removed and replaced by the Contractor at no additional cost.

#### 1.07 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Systems."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

#### 1.08 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

### **PART 2 - PRODUCTS**

#### 2.01 INSULATION MATERIALS

- A. Products shall not contain CFC, asbestos, lead, mercury, or mercury compounds.
- B. Insulation shall meet fire and smoke hazard ratings as tested under procedure ASTM E-84, NFPA 255, and UL 723 and shall not exceed flame spread rating of 25 and maximum smoke developed rating of 50.
- C. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Johns Manville's Micro-Lok *HP* all-service (ASJ) vapor-retarder jacket with a self-sealing longitudinal closure lap (SSL) and butt strips.
    - ii. Owens Corning; ASJ Fiberglas Pipe Insulation.
  - 2. Preformed mineral fiber pipe insulation with factory applied all-service vapor-retarder jacket (ASJ) jacket with a self-sealing longitudinal closure lap (SSL) and butt strips or approved alternate to seal butt joints. Preformed mineral fiber pipe insulation shall conform to ASTM C547. The ASJ facing shall conform to ASTM C1136 Type I.
  - 3. Thermal conductivity (k-value): 0.23 Btu-in/hr-ft<sup>2</sup>-°F at 75°F

4. Preformed mineral fiber pipe insulation shall have a water vapor sorption of less than 5% by weight as tested in accordance ASTM C 547.
5. All service jacket (ASJ) shall have a water vapor permeance of 0.02 perms or less as tested in accordance to ASTM E96, procedure "A".
6. When a vapor mastic is required, a water vapor permeance of 0.02 per ASTM E-96 Procedure B must be achieved.
7. All accessory materials such as field installed jackets, mastics, coatings, tapes, fasteners shall be recommended by each component manufacturer for the specified application or as listed in the NAIMA Guide to Insulating Chilled Water Systems with Mineral Fiber Pipe Insulation.
8. Fittings, valves, tees, etc. shall be insulated with fiberglass insulation inserts covered with white PVC insulated fitting covers.

D. Phenolic Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
  - i. Dyplast Products. Dytherm Phenolic
  - ii. Resolco Inc. Insul-Phen Green.
  - iii. Polyguard.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Thermal conductivity (k-value): 0.18 Btu-in/hr-ft<sup>2</sup>-°F at 75°F
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585

E. Flexible Elastomeric Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
  - i. Armacell LLC Armaflex.
  - ii. Aeroflex USA, Inc. Aerocel.
  - iii. K-Flex USA Insul-sheet.
2. Closed-cell. Comply with ASTM C 534, Type I for tubular materials.
3. Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
4. Pipe insulation shall be fabricated according to the requirements of ASTM C1639 "Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation".
5. Thermal Conductivity: 0.25 Btu-in/hr-ft<sup>2</sup>-°F at 75°F.
6. Short runs of pipe or valves and fittings where it is impractical to install tubing insulation shall be insulated with two layers of 1/4" elastomeric foam tape.

## 2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated. Adhesives shall contain no flammable solvents if that option is available.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Aeroflex USA Inc.; Aeroseal.
    - ii. Armacell LCC; 520 BLV Adhesive.
    - iii. Foster Products Corporation, H. B. Fuller Company; 85-75.
    - iv. RBX Corporation; Rubatex Contact Adhesive.
  2. For indoor applications use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Design Polymeric DP 2590-CA
    - ii. ITW TACC, Division of Illinois Tool Works; SP80, T1080
    - iii. Marathon Industries, Inc.
  2. For indoor applications use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Design Polymeric DD2590-CA.
    - ii. ITW TACC, Division of Illinois Tool Works; SP80, T1080
    - iii. Marathon Industries, Inc.
  2. For indoor applications use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Dow Chemical Company (The); 739, Dow Silicone.
    - ii. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - iii. P.I.C. Plastics, Inc.; Welding Adhesive.
    - iv. Speedline Corporation; Speedline Vinyl Adhesive.
  2. For indoor applications use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.03 MASTICS

- A. Materials shall water based and be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 40 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Childers Products, Division of ITW; CP-35.

- ii. Design Polymerics 3040 with zero VOC's.
  - iii. Foster Products Corporation, H. B. Fuller Company; 30-90.
- 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F.
- 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
- 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Childers Products, Division of ITW; CP-10.
    - ii. Foster Products Corporation, H. B. Fuller Company; 35-00.
    - iii. ITW TACC, Division of Illinois Tool Works; CB-05/15.
  - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: 60 percent by volume and 66 percent by weight.
  - 5. Color: White.

## 2.04 SEALANTS

### A. Joint Sealants:

- 1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
  - i. Childers Products, Division of ITW; CP-76.
  - ii. Foster Products Corporation, H. B. Fuller Company; 30-45.
  - iii. Marathon Industries, Inc.; 405.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Permanently flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 100 to plus 300 deg F.
- 5. Color: White or gray.
- 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### B. FSK and Metal Jacket Flashing Sealants:

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - i. Childers Products, Division of ITW; CP-76-8.
  - ii. Foster Products Corporation, H. B. Fuller Company; 95-44.
  - iii. Marathon Industries, Inc.; 405.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: Aluminum.

6. For indoor applications use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - i. Childers Products, Division of ITW; CP-76.
  - ii. Or equal.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications and use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 FACTORY-APPLIED JACKETS

A. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.06 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:
  - i. Johns Manville; Zeston.
  - ii. P.I.C. Plastics, Inc.; FG Series.
  - iii. Proto Corporation; LoSmoke.
  - iv. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. PVC Jacket Color:
  - i. Chilled-Water Piping:
    - 1) Chilled Water Supply: Dark Blue
    - 2) Chilled Water Return: Light Blue
  - ii. Heating Hot Water Piping:
    - 1) Heating Hot Water Supply: Dark Red
    - 2) Heating Hot Water Return: Light Red
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

- i. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Moisture Barrier Jacket:
  - 1. Manufacturer: Pittsburg Corning PITTWRAP or approved equal.
  - 2. 125 mil thick heat-seal multi-ply laminate consisting of three layers of a polymer-modified bituminous compound separated by glass reinforcement and aluminum foil.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Childers Products, Division of ITW; Metal Jacketing Systems.
    - ii. PABCO Metals Corporation; Surefit.
    - iii. RPR Products, Inc.; Insul-Mate.
  - 2. Factory cut and rolled to size.
  - 3. Finish and thickness are indicated in field-applied jacket schedules.
  - 4. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
  - 5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and 40 pound kraft paper.
  - 6. Factory-Fabricated Fitting Covers:
    - i. Same material, finish, and thickness as jacket.
    - ii. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - iii. Tee covers.
    - iv. Flange and union covers.
    - v. End caps.
    - vi. Beveled collars.
    - vii. Valve covers.
    - viii. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

## 2.07 REMOVABLE INSULATION JACKETS

- A. Manufacturers:
  - 1. ThermaXX LLC.
  - 2. INSULTECH.
  - 3. Firwin.
- B. Insulation:
  - 1. Glass mat, type E needled fiber, 1" at 11.3 LB/CF.
  - 2. Maximum Use Temperature 400 deg F.
- C. Jacket:
  - 1. Hot Side



- i. PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
    - ii. Estimation of Maximum Use Temperature 550 deg F.
  - 2. Cold Side
    - i. PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
    - ii. Estimation of Maximum Use Temperature 600 deg F.
- D. Thread:
  - 1. Does not decompose below 800 deg F.
  - 2. Does not melt.
  - 3. Diameter: 0.0114
  - 4. Break Point: 35 Lbs.
- E. Construction:
  - 1. Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two (2) parallel rows of stitching. The thread must be able to withstand the skin temperatures without degradation.
  - 2. Hog rings, staples, and wire are not acceptable methods of closure.
  - 3. No raw cut jacket edges shall be exposed.
  - 4. Jackets shall be fastened using hook and loop (Velcro) straps and 1" slide buckles.
  - 5. Provide a permanently attached aluminum or stainless-steel nameplate on each jacket to identify its location, size, and tag number.
  - 6. Provide a stainless steel or brass grommet at the low point of each jacket, in wet areas for moisture drain (on horizontal jackets as required).
  - 7. The insulation shall be designed to minimize the convection current in the space between the hot metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.
  - 8. All jacket pieces which match mating seams must include an extended 2" flap constructed from the exterior fabric and shall be secured using hook & loop closure (Velcro) parallel to the seam.
  - 9. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.

## 2.08 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - i. ABI, Ideal Tape Division; 428 AWF ASJ.
    - ii. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - iii. Compac Corporation; 104 and 105.
    - iv. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  - 2. Width: 3 inches.
  - 3. Thickness: 11.5 mils
  - 4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
    - i. ABI, Ideal Tape Division; 491 AWF FSK.
    - ii. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - iii. Compac Corporation; 110 and 111.
    - iv. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    - ii. Compac Corp.; 130.
    - iii. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    - iv. Venture Tape; 1506 CW NS.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
    - i. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - ii. Compac Corp.; 120.
    - iii. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - iv. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.

6. Tensile Strength: 34 lbf/inch in width.

## 2.09 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch thick, 1/2 inch 3/4 inch wide with closed seal.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following]:
    - i. ITW Insulation Systems; Gerrard Strapping and Seals.
    - ii. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, Monel.
  1. Manufacturers: Subject to compliance with requirements, provide product by:
    - i. C & F Wire.
    - ii. Childers Products.
    - iii. PABCO Metals Corporation.
    - iv. RPR Products, Inc.

## **PART 3 - EXECUTION**

### 3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify all inspection and acceptance testing of the piping as required by the specification has been completed and that the piping is ready for installation of insulation.
  2. Verify that surfaces to be insulated are clean and dry.
  3. Proceed with installation only after unsatisfactory conditions have been corrected.
  4. Verify there is adequate clearance to install the pipe insulation in accordance with the operation performance parameters of the specification, such as access to controls, valves and for maintenance and repair.

### 3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Insulation shall not be installed until the following have been completed and documentation has been submitted to Owner for approval and record:
  1. Cleaning and flushing
  2. Pressure testing
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

- D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. Install rigid pre-insulated pipe supports to protect from compression of insulation material due to point loads.
- L. Provide aluminum sleeves at all pipe support joints, between hanger support and exterior layer of insulating systems, to protect from compression of insulation material due to point loads.
- M. Install insulation on piping accessories requiring future reoccurring access and service with factory fabricated insulation covers that are easily removed and reapplied.
- N. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- P. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1.5 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - i. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- S. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- T. Existing pipe insulation damaged or affected by the work of this contract shall be repaired to comply with these specifications except that materials and thicknesses may match existing unless otherwise directed by the Owner's Representative.
- U. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

### 3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations: Install insulation continuously through walls and partitions.
- C. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- B. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- C. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and

pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.06 INSTALLATION OF MINERAL-FIBER INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
5. On chilled water systems, the butt end of every fourth pipe insulation section, and the ends or raw edges of insulation terminations at equipment connections, fittings and fire stop systems shall be sealed with vapor retarder mastic per NAIMA Guide to Insulation Chilled Water Systems, 2015.

#### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

### 3.07 INSTALLATION OF PHENOLIC INSULATION

#### A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

#### B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

#### D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

#### E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

### 3.08 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

#### A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.



3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.09 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1.5-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install as follows:

1. With 1-inch overlap at longitudinal seams and end joints; for horizontal applications.
2. Seal with manufacturer's recommended adhesive.
3. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install as follows:

1. With 2-inch overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water.
3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.
4. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

3.12 ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water Supply and Return, Outdoors, 40°F and above:

1. NPS 1.25 inch and smaller: Phenolic, pre-formed pipe insulation, 0.5 inch thick.
2. NPS 1.5 inch and larger: Phenolic, pre-formed pipe insulation, 1 inch thick.

- B. Chilled Water Supply and Return, Indoors, 40°F and above:

1. NPS 1.25 inch and smaller: Mineral Fiber, pre-formed pipe insulation, 0.5 inch thick.
2. NPS 1.5 inch and larger: Mineral Fiber, pre-formed pipe insulation, 1 inch thick.

- C. Heating Hot Water Supply and Return, 200°F and below:

1. NPS 1.25 inch and smaller: Mineral Fiber, pre-formed pipe insulation, 1.5 inches thick.
2. NPS 1.5 inch and larger: Mineral Fiber, pre-formed pipe insulation, 2 inches thick.

- D. Refrigerant Piping:

1. Low Pressure Vapor Line, below 40°F: Flexible elastomeric, 1 inch thick.
2. Low Pressure Vapor Line, 40°F and above: Flexible elastomeric, 0.5 inch thick.
3. High Pressure Vapor Line, 141°F to 200°F: Flexible elastomeric, 1.5 inches thick.
4. High Pressure Vapor Line, 201°F to 250°F: Flexible elastomeric, 2.5 inches thick.
5. Liquid Line, 140°F and below: Flexible elastomeric, 1 inch thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed: None.
- C. Piping, Exposed: PVC, Color-Coded by system, 30 mils thick for all indoor applications.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed: None.
- C. Piping, Exposed: Aluminum, Stucco Embossed, 0.024 inch thick.

**END OF SECTION**

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## SECTION 23 08 01

### COMMISSIONING OF MECHANICAL SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 INTRODUCTION

- A. The Architect contracts a commissioning agent for this project. This specification details the roles and responsibilities of each project team member as they apply to commissioning. Each contractor should review this procedure and include adequate time in their proposal.

##### 1.02 RELATED DOCUMENTS

- A. Contract drawings and specifications, general provisions of the contract, including general and supplementary conditions, mechanical provisions and Division-1 Specification sections apply to work of this section.

##### 1.03 DESCRIPTION OF WORK

- A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Design Intent Documents (DID). The CxA shall provide the owner with an unbiased, objective view of the system's design, installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CxA will be a member of both the design and construction team. During the design phase, the CxA will assist the owner in development of the Owner's Project Requirements, review the Basis of Design, and develop project-specific commissioning specifications. During the construction phase, the CxA will administer and coordinate commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers which will include commissioning coordination meetings, equipment installation inspections, functional performance testing, issues resolution, and documentation of all aforementioned tasks and activities.

##### 1.04 REFERENCES

- A. Specification Section 01 91 13 - General Commissioning Requirements
- B. ASHRAE Guideline 0 - 2019
- C. ASHRAE Guideline 1-2007

#### **Part 2 – PRODUCTS (Not applicable)**

#### **Part 3 – EXECUTION**

##### 3.01 ROLES AND RESPONSIBILITIES OF THE COMMISSIONING AGENCY

- A. Mission: The primary point of responsibility is to inform the general contractor, the owner and design team on the status, integration, and performance of mechanical and electrical systems within the facility.
- B. Information: The CxA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting

construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owners O&M staff.

- C. Quality Assurance: Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.
- D. Observation of Tests: The CxA shall observe and coordinate testing as required to assure system performance meets the design intent.
- E. Documentation of Tests: The CxA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CxA shall compile standard forms to be used by the commissioning team for consistency of approach and type of information to be recorded.
- F. Deficiencies: The CxA shall provide technical expertise to facilitate and verify the correction of deficiencies found during the commissioning process.
- G. Resolution of Deficiencies: The CxA is to remain an independent party with specific technical knowledge of the project. The CxA shall investigate the scope and extent of problems and facilitate communication to determine responsibilities by delineating specifications. The CxA shall monitor resolution for conformance with design intent and prevailing industry standards.
- H. Acceptance: The CxA shall document the date of acceptance as determined by the General Contractor, owner and design team.
- I. Certificate(s) of Installation, Certificate(s) of Acceptance and Functional Performance Test results may be used in determining the start of the warranty period for HVAC and lighting systems and subsystems.

### 3.02 ROLES AND RESPONSIBILITIES OF THE OWNER

- A. Assign facilities personnel and schedule them to participate in the various meetings, training sessions and inspections as follows:
  - 1. It is in the Owner's best interest to have facilities staff attend the following meetings:
    - a. Owners training session(s).
    - b. Contractors' commissioning kick-off meeting
      - 1) At the kickoff meeting, the Owner will indicate to GC whether facilities staff will attend any of the meetings detailed below.
  - 2. It is at the Owner's discretion to have facilities staff attend the following Cx meetings:
    - a. Equipment start-up events.
    - b. Piping and ductwork testing and acceptance.
    - c. Functional performance testing of HVAC equipment.

### 3.03 ROLES AND RESPONSIBILITIES OF THE DESIGN TEAM DURING CONSTRUCTION

- A. Provide update to the Basis of Design Narrative.
- B. Verify adequate maintenance accessibility for each piece of equipment in shop drawings and actual installation. Visit site periodically and inspect construction.
- C. Review TAB report from Contractor against design requirements and issue response to entire commissioning team.

### 3.04 MECHANICAL SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

- A. HVAC Systems:
  - 1. Chiller Plant
  - 2. Boiler Plant

3. (E) Air handling units.
4. Exhaust fans.
5. Variable air volume (VAV) boxes
6. Building HVAC control system(s).

### 3.05 HVAC COMMISSIONING PLAN

#### A. Commissioning Team

1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:
  - a. Program Manager/Owner (PrM)
  - b. Commissioning Agent (CxA)
  - c. Design Team (DT)
  - d. General Contractor (GC)
  - e. Mechanical Contractor (MC)
  - f. Controls Contractor (ATC)
  - g. Testing, Adjusting and Balancing Contractor (TAB)
  - h. Electrical Contractor (EC)

#### B. Design Intent Document

1. The Design Intent Document (DID) represents a composite of design drawings, project specifications, submittals, change orders and industry standards, prepared by the designer of record, that describe the systems of this facility. References to design intent will be taken from the DID. The DID is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
2. The CxA will review the DID documents for commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

#### C. Commissioning Meetings

1. Commissioning meetings will be held in conjunction with progress meetings when possible and as necessary.
2. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

#### D. Resolution Tracking Forms (RTF)

1. The use of Resolution Tracking Forms is a method employed by the CxA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CxA will regularly submit RTF's to the CT in order to document and resolve

deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. Certificate(s) of Installation/ Manufacturer's Checklists

1. Copies of the System Verification Checklists shall be provided to the CxA within 7 days of request.
2. Copies of the manufacturer's startup forms shall be provided to the CxA within 7 days of request.

F. Start-Up

1. The CxA will witness start-up of major systems at their discretion. The systems to be witnessed will be identified and discussed during the Cx construction kickoff meeting. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up.
2. The installing contractor shall notify the CxA no later than 7 days prior to startup of equipment.

G. Functional Performance Tests (FPT)

1. The CxA will write FPT's based on the design intent document. These tests will be created for systems and subsystems.
2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CxA. A minimum of 30% of sub-systems will be tested. If more than a 10% failure rate occurs, all sub-systems will be tested at the contractor's cost.
3. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.

H. Building Turn-Over / Owner Orientation / User Training

1. The CxA may review O&M manuals, to ensure specificity and completeness.
2. The CxA will review as-built drawings, to ensure specificity and completeness.
3. The installing contractor or manufacturer's representative will provide the training. This training should include both classroom training and hands-on operational training.
4. The CxA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

I. Training of Owner's Operators

1. The Owner's facility staff shall be given comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of equipment.
2. The GC will be responsible for scheduling the training which shall start with classroom sessions followed by hands on training on each piece of equipment. Hands on training shall include start-up, operation in all modes possible, shut-down and any emergency procedures.
3. The manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall review safe and proper operating requirements and preventative maintenance.
4. Training will be included for all major pieces of equipment including pumps, chillers,

boilers, hot water heaters, heat rejection equipment, air conditioning units, air handling units, fans, air terminals, controls and water treatment systems.

5. Each classroom training session shall be followed by an inspection, explanation and demonstration of the equipment. The start-up and shut-down modes of operation shall be demonstrated.
6. The ATC shall conduct the training session on the controls system hardware and software.

K. Systems Manual

1. Systems manual shall be provided by the CxA
2. Training of the content of the systems manual shall be provided by the CxA.
3. Content of the Systems Manual shall be, at a minimum, as follows:
  - a. Site Information
  - b. Site Contact Information
  - c. General Site Operating Procedures
  - d. Major Systems Description
  - e. Site Equipment Inventory and Maintenance
  - f. Miscellaneous References and Documentation

3.06 RESPONSIBILITIES OF INSTALLING CONTRACTORS

A. General Contractor (GC)

1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the commissioning process.
2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the commissioning program as described in the contract documents.
3. Assure that the CxA shall receive a copy of all construction documents, addenda, change orders and appropriate submittals and shop drawings for review and use in development of the commissioning plan and functional performance tests.
  - a. The GC shall provide the CxA with the submittal log.
  - b. The CxA will identify the equipment and/or systems the CxA needs to review and will return the marked up submittal log to the GC.
  - c. The GC shall ensure all submittals for equipment/systems identified are delivered to the CxA for review.
  - d. Comments and/or questions associated with each submittal will be directed to the design team for inclusion/exclusion of the design team's comments.
  - e. Coordinate inclusion of commissioning activities in the construction schedule.
  - f. Issue a statement that TAB work has been completed, and that the final TAB report has been submitted for review.
  - g. Issue a statement that control systems have been completely installed and calibrated
  - h. Coordinate Owner training activities with the Owner and each trade's respective contractor.



- i. Facilitate resolution of deficiencies identified by observation or performance testing.

**B. Mechanical Contractor (MC)**

1. Include cost for commissioning requirements in the contract price.
2. Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.
3. Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.
4. Attend commissioning meetings scheduled by the CxA.
5. Assist the CxA in system verification and performance testing.
6. Prepare preliminary schedule for HVAC system inspections, O & M manual submission, training sessions, duct system testing, flushing and cleaning, equipment start-up, system verification, performance testing, and system completion for use by the CxA. Update schedule as appropriate throughout the construction period and provide updated schedule to the commissioning team.
7. Complete System Verification Checklists and manufacturer's pre-startup checklists prior to scheduling startup of HVAC equipment.
  - a. Retain System Verification Checklists in a 3-ring binder in an organized fashion. Binder is to remain on the job site
  - b. Make System Verification Checklists available for CxA review upon request.
  - c. Monitor and respond to Resolution Tracking Forms distributed by the CxA in order to expedite corrective actions necessary to achieve design intent.
  - d. Notify the CxA a minimum of one week in advance of scheduled system start-up.
  - e. Update drawings to as-built condition and review with the CxA throughout the construction process.
  - f. Schedule vendor and subcontractor provided training sessions as required by project specifications.
  - g. Provide written notification to the GC and CxA that the following work has been completed in accordance with the project specifications, and that the equipment, systems and subsystems are operating in accordance with design intent.
    - 1) HVAC equipment including chiller and associated pumps, boilers and associated pumps, fans, air handling units, VAV boxes, ductwork, dampers, etc.
  - h. Participate in the Functional Performance Tests as required to achieve design intent.
  - i. Participate in O&M Training as required by project specifications.
  - j. Provide a complete set of as-built drawings and O&M manuals of equipment installed by the MC to the GC for inclusion in the project documentation.

**C. Test and Balance (TAB) Agency**

1. With respect to HVAC commissioning, the TAB agency shall:
  - a. Include costs for HVAC commissioning requirements in the quoted price.
  - b. Attend commissioning meetings scheduled by the CA prior to, and during,

on-site TAB work being done.

- c. Submit proposed TAB procedures to the CA and mechanical engineer for review and acceptance.
- d. Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the HVAC system.
- e. At the completion of the TAB work, submit the final TAB report to the general contractor with copies to the Owner, CA and mechanical engineer.
- f. Participate in verification of the TAB report by the CA for verification or diagnostic purposes. This will consist of repeating a sample (10%) of the measurements contained in the TAB report as directed by the CA.
- g. Participate in O & M personnel training sessions as scheduled by the CA.

#### D. Controls Contractor

- 1. With respect to HVAC commissioning, the controls contractor shall:
  - a. Include cost for commissioning requirements in the quoted price.
  - b. Review design for controllability with respect to equipment selected for the project;
    - 1) Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.
    - 2) Review and confirm in writing that proper safeties and interlocks are included in design.
    - 3) Ensure the proper selection of sensor ranges and include data with submittal to mechanical engineer.
    - 4) Clarify all questions concerning sequences of operation with the mechanical engineer.
  - c. Attend commissioning meetings scheduled by the CA.
  - d. Provide the following submittals to the CA for review;
    - 5) Hardware and software submittals.
    - 6) Diagrams showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.
    - 7) Narrative description of all control sequences for each piece of equipment controlled.
    - 8) A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
    - 9) Hardware operation and maintenance manuals.
    - 10) Application software and project applications code manuals.
  - e. Inspect, check, and confirm the proper installation and performance of controls/BAS hardware and software provided by others.
  - f. Integrate installation and programming scheduling with construction and commissioning schedules.
  - g. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
  - h. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance

with the O&M staff training program in the commissioning plan.

- i. In conjunction with the mechanical contractor, demonstrate system performance to the CA including all modes of system operation (e.g. occupied, unoccupied, emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA.
- j. Provide control system technician to assist during system verification and functional performance testing.
- k. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and commissioning agencies, all devices and all software for the TAB agency to use in completing TAB procedures.

**END OF SECTION**

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## SECTION 23 09 23

### DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

###### B. Related Requirements:

1. Section 230993 "Sequence of Operations for HVAC Controls" for control sequences in DDC systems.
2. Raceways:
  - i. Section 260533 "Raceways and Boxes for Electrical Systems" for raceways for low-voltage control cable.
3. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical components.

##### 1.03 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. BACnet Specific Definitions:
  1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
  2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
  3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
  4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
  5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.
- D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

- E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- G. COV: Changes of value.
- H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
- J. DOCSIS: Data-Over Cable Service Interface Specifications.
- K. E/P: Voltage to pneumatic.
- L. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- M. HLC: Heavy load conditions.
- N. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- O. I/P: Current to pneumatic.
- P. LAN: Local area network.
- Q. LNS: LonWorks Network Services.
- R. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- S. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- T. Modbus TCP/IP: An open protocol for exchange of process data.
- U. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- V. MTBF: Mean time between failures.
- W. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
- X. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- Y. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- Z. POT: Portable operator's terminal.
- AA. PUE: Performance usage effectiveness.
- BB. RAM: Random access memory.

CC.RF: Radio frequency.

DD.Router: Device connecting two or more networks at network layer.

EE. Server: Computer used to maintain system configuration, historical and programming database.

FF. TCP/IP: Transport control protocol/Internet protocol.

GG. UPS: Uninterruptible power supply.

HH.USB: Universal Serial Bus.

II. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

JJ. VAV: Variable air volume.

KK. WLED: White light emitting diode.

#### 1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

#### 1.05 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product as applicable.
  - i. Workstations.
  - ii. Servers.
  - iii. Printers.
  - iv. Gateways.
  - v. Routers.

- vi. Protocol analyzers.
- vii. DDC controllers.
- viii. Enclosures.
- ix. Electrical power devices.
- x. UPS units.
- xi. Accessories.
- xii. Instruments.
- xiii. Control dampers and actuators.
- xiv. Control valves and actuators.

- 6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
- 7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

- 1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
- 2. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
- 3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
- 4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
- 5. Listing and description of each engineering equation used with reference source.
- 6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
- 7. Description of operator interface to alphanumeric and graphic programming.
- 8. Description of each network communication protocol.
- 9. Description of system database, including all data included in database, database capacity and limitations to expand database.
- 10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughput.
- 11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

- 1. General Requirements:
  - i. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
  - ii. Include a drawing index sheet listing each drawing number and title that matches information in each title block.

- iii. Drawings Size: 11"x17".
2. Include plans, elevations, sections, and mounting details where applicable.
  3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  4. Detail means of vibration isolation and show attachments to rotating equipment.
  5. Plan Drawings indicating the following:
    - i. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
    - ii. Room names and numbers with coordinated placement to avoid interference with control products indicated.
    - iii. Each desktop workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
    - iv. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
    - v. Network communication cable and raceway routing.
    - vi. Information, drawn to scale, of 1/4 inch per foot.
    - vii. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.
  6. Schematic drawings for each controlled HVAC system indicating the following:
    - i. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
    - ii. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
    - iii. A graphic showing location of control I/O in proper relationship to HVAC system.
    - iv. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
    - v. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
    - vi. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
    - vii. Narrative sequence of operation.
    - viii. Graphic sequence of operation, showing all inputs and output logical blocks.
  7. Control panel drawings indicating the following:
    - i. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
    - ii. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
    - iii. Front, rear, and side elevations and nameplate legend.



- iv. Unique drawing for each panel.
- 8. DDC system network riser diagram indicating the following:
  - i. Each device connected to network with unique identification for each.
  - ii. Interconnection of each different network in DDC system.
  - iii. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
  - iv. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
- 9. DDC system electrical power riser diagram indicating the following:
  - i. Each point of connection to field power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
  - ii. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
  - iii. Each product requiring power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
  - iv. Power wiring type and size, race type, and size for each.
- 10. Monitoring and control signal diagrams indicating the following:
  - i. Control signal cable and wiring between controllers and I/O.
  - ii. Point-to-point schematic wiring diagrams for each product.
  - iii. Control signal tubing to sensors, switches, and transmitters.
  - iv. Process signal tubing to sensors, switches, and transmitters.
- 11. Color graphics indicating the following:
  - i. Itemized list of color graphic displays to be provided.
  - ii. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
  - iii. Intended operator access between related hierarchical display screens.

E. System Description:

- 1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
- 2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
- 3. System and product operation under each potential failure condition including, but not limited to, the following:
  - i. Loss of power.
  - ii. Loss of network communication signal.
  - iii. Loss of controller signals to inputs and outpoints.
  - iv. Operator workstation failure.
  - v. Server failure.

- vi. Gateway failure.
- vii. Network failure
- viii. Controller failure.
- ix. Instrument failure.
- x. Control damper and valve actuator failure.
- 4. Complete bibliography of documentation and media to be delivered to Owner.
- 5. Description of testing plans and procedures.
- 6. Description of Owner training.

#### 1.06 INFORMATIONAL SUBMITTALS

##### A. Qualification Data:

##### 1. Systems Provider Qualification Data:

- i. Resume of project manager assigned to Project.
- ii. Resumes of application engineering staff assigned to Project.
- iii. Resumes of installation and programming technicians assigned to Project.
- iv. Resumes of service technicians assigned to Project.
- v. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
- vi. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
- vii. Names of staff assigned to past project that will also be assigned to execute work of this Project.
- viii. Owner contact information for past project including name, phone number, and e-mail address.
- ix. Contractor contact information for past project including name, phone number, and e-mail address.
- x. Architect and Engineer contact information for past project including name, phone number, and e-mail address.

##### 2. Manufacturer's qualification data.

##### 3. Testing agency's qualifications data.

##### B. Product Certificates:

- 1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.

##### C. Product Test Reports: For each product that requires testing to be performed by a qualified testing agency.

##### D. Preconstruction Test Reports: For each separate test performed.

##### E. Source quality-control reports.

##### F. Field quality-control reports.

##### G. Sample Warranty: For manufacturer's warranty.

#### 1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation, and maintenance manuals.

1. Include the following:

- i. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
- ii. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
- iii. As-built versions of submittal Product Data.
- iv. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
- v. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
- vi. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
- vii. Engineering, installation, and maintenance manuals that explain how to:
  - 1) Design and install new points, panels, and other hardware.
  - 2) Perform preventive maintenance and calibration.
  - 3) Debug hardware problems.
  - 4) Repair or replace hardware.
- viii. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- ix. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
- x. List of recommended spare parts with part numbers and suppliers.
- xi. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- xii. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- xiii. Licenses, guarantees, and warranty documents.
- xiv. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- xv. Owner training materials.

#### 1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.

#### 1.09 QUALITY ASSURANCE

##### A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of 10 years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least five past projects.
4. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
  - i. Product research and development.
  - ii. Product and application engineering.
  - iii. Product manufacturing, testing and quality control.
  - iv. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
  - v. Owner operator training.

##### B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within 60 miles of Project.
3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope and value.
5. Each person assigned to Project shall have demonstrated past experience.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

#### 1.10 PRECONSTRUCTION TESTING

##### A. Preconstruction Testing: Performed by installing DDC contractor or a qualified testing agency engaged by installing contractor on existing systems prior to demolition.

1. Perform point-to-point checkout and commissioning of existing indoor air handling units AHU-1, AHU-2, and AHU-3. Confirm that all end devices and sensors are installed and operating within allowable tolerances to achieve sequences of operation as described in Section 230993.

2. Perform testing of existing roof exhaust fan EF-2. Confirm that fan responds to on/off signal and provides status via current switch.
  3. Perform testing of existing inline exhaust fan EF-3. Confirm that fan responds to on/off/speed signal from thermostat and provides status via current switch.
- B. Provide testing report to Owner within two weeks of preconstruction testing. Identify all DDC components and end devices that are found to be faulty and provide estimated replacement cost.

#### 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
  2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
    - i. Install updates only after receiving Owner's written authorization.
  3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
  4. Warranty Period: Two year from date of Substantial Completion.
    - i. For Gateway: Two-year parts and labor warranty for each.

### **PART 2 - PRODUCTS**

#### 2.01 DDC SYSTEM MANUFACTURERS

- A. Alerton
- B. Automated Logic
- C. Johnson Controls
- D. Siemens
- E. Or Engineer's approved equal

#### 2.02 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, operator interfaces, and software.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 2.03 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to the latest version of ASHRAE/ANSI Standard 135, BACnet.
- B. Install new wiring and network devices as required providing a complete and workable control network.

- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
  - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
  - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in this section. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.
- G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
  - 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
  - 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
  - 3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
  - 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

## 2.04 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 25 or less.
  - 2. Smoke-Developed Index: 50 or less.
- B. DDC System Speed:
  - 1. Response Time of Connected I/O:

- i. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    - ii. BI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    - iii. AO points connected to DDC system shall begin to respond to controller output commands within two seconds. Global commands shall also comply with this requirement.
    - iv. BO point values connected to DDC system shall respond to controller output commands within two seconds. Global commands shall also comply with this requirement.
  - 2. Display of Connected I/O:
    - i. Analog point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
    - ii. Binary point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
    - iii. Alarms of analog and digital points connected to DDC system shall be displayed within 45 seconds of activation or change of state.
    - iv. Graphic display refresh shall update within eight seconds.
    - v. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
- C. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- D. DDC System Data Storage:
  - 1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
  - 2. Local Storage:
    - i. Provide workstation with data storage indicated. Server(s) shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.
  - 3. Cloud Storage:
    - i. Provide application-based and web browser interfaces to configure, upload, download, and manage data, and service plan with storage adequate to store all data for term indicated. Cloud storage shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.
- E. DDC Data Access:
  - 1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.

2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

F. Future Expandability:

1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

G. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion. The requirements here are state for verification and measurement purposed and do not reduce the accuracy requirements of sensors and other components specified

1. Energy:
  - i. Thermal: Within 1 percent of reading.
  - ii. Electric Power: Within 1 percent of reading.
  - iii. Requirements indicated on Drawings for meters not supplied by utility.
2. Flow:
  - i. Air: Within 5 percent of design flow rate.
  - ii. Air (Terminal Units): Within 10 percent of design flow rate.
  - iii. Water: Within 5 percent of design flow rate.
3. Gas:
  - i. Carbon Dioxide: Within 50 ppm.
  - ii. Carbon Monoxide: Within 5 percent of reading.
4. Moisture (Relative Humidity):
  - i. Air: Within 5 percent RH.
  - ii. Space: Within 5 percent RH.
  - iii. Outdoor: Within 5 percent RH.
5. Pressure:
  - i. Air, Ducts and Equipment: 1 percent of instrument range.
  - ii. Space: Within 1 percent of instrument range.
  - iii. Water: Within 1 percent of instrument range.
6. Velocity: Within 10 percent of reading.
7. Temperature, Dew Point:
  - i. Air: Within 1 deg F.
  - ii. Space: Within 1 deg F.
  - iii. Outdoor: Within 3 deg F.



8. Temperature, Dry Bulb:
- i. Air: Within 1 deg F.
  - ii. Space: Within 1 deg F.
  - iii. Outdoor: Within 2 deg F.
  - iv. Chilled Water: Within 1 deg F.
  - v. Heating Hot Water: Within 1 deg F.
  - vi. Temperature Difference: Within 0.25 deg F.

9. Temperature, Wet Bulb:
- i. Air: Within 1 deg F.
  - ii. Space: Within 1 deg F.
  - iii. Outdoor: Within 2 deg F.

H. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:

- 1. Current:
  - i. Milliampere: Nearest 1/100th of a milliampere.
  - ii. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
- 2. Energy:
  - i. Electric Power:
    - 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
    - 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
    - 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
  - ii. Thermal, Rate:
    - 1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh.
    - 2) Cooling: For tons, nearest ton up to 1000 tons.
  - iii. Thermal, Usage:
    - 1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.
    - 2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.
- 3. Flow:
  - i. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.

- ii. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm.
  - 4. Gas:
    - i. Carbon Dioxide (ppm): Nearest ppm.
    - ii. Carbon Monoxide (ppm): Nearest ppm.
  - 5. Moisture (Relative Humidity):
    - i. Relative Humidity (Percentage): Nearest 1 percent.
  - 6. Speed:
    - i. Rotation (rpm): Nearest 1 rpm.
    - ii. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000.
  - 7. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
  - 8. Pressure:
    - i. Air, Ducts and Equipment: Nearest 1/10th in. w.c.
    - ii. Space: Nearest 1/100th in. w.c.
    - iii. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig.
  - 9. Temperature:
    - i. Air, Ducts and Equipment: Nearest 1/10th of a degree.
    - ii. Outdoor: Nearest degree.
    - iii. Space: Nearest 1/10th of a degree.
    - iv. Chilled Water: Nearest 1/10th of a degree.
    - v. Heating Hot Water: Nearest degree.
  - 10. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.
- I. Control Stability: Control variables indicated within the following limits:
- 1. Flow:
    - i. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
    - ii. Air, Terminal Units: Within 10 percent of design flow rate.
    - iii. Water: Within 5 percent of design flow rate.
  - 2. Gas:
    - i. Carbon Dioxide: Within 50 ppm.
    - ii. Carbon Monoxide: Within 5 percent of reading.
  - 3. Moisture (Relative Humidity):
    - i. Air: Within 5 percent RH.
    - ii. Space: Within 5 percent RH.
    - iii. Outdoor: Within 5 percent RH.
  - 4. Pressure:
    - i. Air, Ducts and Equipment: 1 percent of instrument range.

- ii. Space: Within 1 percent of instrument range.
  - iii. Water: Within 1 percent of instrument range.
- 5. Temperature, Dew Point:
  - i. Air: Within 1 deg F.
  - ii. Space: Within 1 deg F.
- 6. Temperature, Dry Bulb:
  - i. Air: Within 2 deg F.
  - ii. Space: Within 2 deg F.
  - iii. Chilled Water: Within 1 deg F.
  - iv. Heating Hot Water: Within 2 deg F.
- 7. Temperature, Wet Bulb:
  - i. Air: Within 1 deg F.
  - ii. Space: Within 1 deg F.
- J. Backup Power Source:
  - 1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.
- K. Continuity of Operation after Electric Power Interruption:
  - 1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

## 2.05 DDC EQUIPMENT AND SOFTWARE

- A. Operator Workstation.
  - 1. Network management tools shall be based upon Tridium Niagara AX Framework technology as developed by the Tridium Corporation. All tools and hardware provided shall comply with the current release version of the AX Niagara Framework platform. The supplied computer software shall employ object-oriented technology for representation of all data and control devices within the system. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135 BACnet technology, and other open communication protocols in one open, interoperable system. Provide open Vykon Niagara AX Java application control engines (JACE's). Private label or proprietary JACEs shall not be accepted.
- B. Graphics software: The graphics shall reside on the Niagara AX platform.
- C. DDC Controllers
  - 1. Communication from JACE's to DDC Controllers shall be via BACnet. Building controller shall incorporate as a minimum, the functions of a 3-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz), master slave token passing (MS/TP) LANs, a point-to-point (PTP – RS-232) connection and modem.
  - 2. Each MS/TP LAN shall be software configurable from 9.6 to 76.8Kbps.

3. Building controller shall be capable of providing global control strategies for the system based on information from any objects in the system regardless if the object is directly monitored by the controller or by another controller. The program that implements these strategies shall be completely flexible and user definable.
4. Programming shall be object-oriented using control function blocks, supporting DDC functions, 1000 Analog Values and 1000 Binary Values. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be resident on workstation and the same tool used for all controllers.
5. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator's workstation or field computer.
6. Building controller shall provide battery-backed real-time (hardware) clock functions.
7. Controller shall have a memory needed to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 2 years (cumulative).

D. Application-Specific controllers:

1. Provide one native BACnet application specific controller for each piece of unitary mechanical equipment that adequately covers all objects listed. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.
2. Zone damper: Actuators shall be electronic with a means for lockable manual override.
3. Provide a metal NEMA 2 enclosure for actuator assembly of the zone controllers.
4. Provide a metal NEMA 2 enclosure for all electronic components of zone controller.

E. Software Capabilities: Update to latest version of software at Project completion. Include and implement the following capabilities from the control units:

1. Units of Measure: Inch-pound and SI (metric).
2. Load Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, DDC with fine tuning, and trend logging.
3. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
4. Programming Application Features: Include trend point, alarm messages, weekly scheduling, and interlocking.
5. Paging: Provide the means of automatic alpha numeric paging of personnel for user defined control system requirements.

## 2.06 CONTROL PANELS

- A. Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels. Provide UL 508A listed panels as a complete assembly.
1. Fabricate panels of 0.06-inch- thick, furniture-quality steel, or extruded- aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
  2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.

3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
  4. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.
  5. Provide one uninterrupted power supply for each main control panel.
- B. Alarm Panels: Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted in hinged-cover enclosure.
1. Alarm Condition: Indicating light flashes and horn sounds.
  2. Acknowledge Switch: Horn is silent and indicating light is steady.
  3. Second Alarm: Horn sounds and indicating light is steady.
  4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
  5. Contacts in alarm panel allow remote monitoring by independent alarm company.
- C. Provide one external Uninterrupted Power Supply (UPS) in NEMA 1 enclosure for every DDC Control Panel. Enclosures on the roof shall be NEMA 12R.

## 2.07 SENSORS AND COMMUNICATION DEVICES

- A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
1. Thermistor Temperature Sensors (Thermistor):
    - i. Accuracy: Plus or minus 0.5 deg F at calibration point.
    - ii. Wire: Twisted, shielded-pair cable.
    - iii. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
  2. Resistance Temperature Detectors (RTD): Platinum.
    - i. Accuracy: Plus or minus 0.2 percent at calibration point.
    - ii. Wire: Twisted, shielded-pair cable.
    - iii. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
    - iv. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
    - v. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
  3. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    - i. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    - ii. Output: 4 to 20 mA.
    - iii. Duct Static-Pressure Range: 0 to 5 inches wg.
  4. Thermal-Energy Meters (CHW AND HHW): Onicon System-10 BACnet MS/TP BTU Meter or equal. Provide system with flow sensor, matched temperature sensors, transmitter, indicator and connecting wiring for interface via BACnet.

5. Water flow meters: Electromagnetic, full-bore inline flow sensor (no moving parts) with corrosion-resistant-metal body and transmitter for installation in piping. Onicon F-3500 Series, or similar.
  - i. Accuracy: + 1.0% of reading at calibrated velocity.
  - ii. Output: 4 to 20 mA.
  - iii. Material rated for type and temperature of fluid.
6. Liquid Pressure Transmitters: Provide Liquid Pressure Sensors with accuracy of
  - i. + 1% operating environment or -40 degrees F to 260 degrees F with output signal of 4-20 mA.
7. Current Sensing Relays: Solid State AC switch with internal current transformer. The switch shall operate when the current level sensed by the internal current transformer exceeds the threshold value set by the adjustment knob. Provide relays with split core design for the range suitable for application. Coordinate with electrical contractor.
8. Current Transformer: Provide current transformers rated for the specified amperage. The transformer shall provide 0 to 5 VDC output signal.
9. Differential Pressure Switches: A diaphragm operated snap switch shall actuate the electrical circuit upon sensing of Differential Pressure. The setpoint range shall be 1 inch WC to 12 inch WC.
10. Electrical Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc feedback signal.
11. Air Flow Measuring Station:
  - i. Provide Ebtron Gold Series thermal dispersion airflow and temperature measurement device (ATMD) equipped with 'C' sensor density probes or approved equal. The stations shall continuously measure the airflow through the duct or louver and transmit that information to the building automation system via 4-20 mA or 0-10 VDC signals. Overall accuracy of the flow measuring station shall be within 2% of actual air flow. Pressure drop shall not exceed .1" water gage.
12. Humidity Sensors: Bulk polymer sensor element.
  - i. Accuracy: 1 percent full range.
  - ii. Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity.
  - iii. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
13. Pressure Transmitters: Direct acting for gas or liquid; range suitable for system; proportional output 4 to 20 mA.
14. Duct Smoke Detectors: Comply with NFPA requirements. Coordinate with Division 26 and Fire Alarm Systems.
15. Water Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vapor-proof type. Coordinate with chiller and boiler manufacturers. Flow switches shall be approved and or provided by these manufacturers.
16. Carbon-Monoxide Detectors: Single or multi-channel, dual-level detectors, using solid-state sensors with 3-year minimum life, suitable over a temperature range of 23

to 130 degrees F, calibrated for 50 to 100 ppm, with maximum 120-second response time to 100 ppm carbon monoxide.

17. Carbon-Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23 to 130 degrees F, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output, and wall mounted.
18. Oxygen Sensor and Transmitter: Single detectors, using solid-state zircon cell sensing, suitable over a temperature range of minus 32 to plus 1100 degrees F, calibrated for 0 to 5 percent, with continuous or averaged reading, 4 to 20 mA output, and wall mounted.
19. Refrigerant Detectors: Dual-level detectors, using solid-state sensors, with alarm preset for 300 ppm, alarm indicator light, alarm silence light button, alarm test light and button, and trouble light. Provide auxiliary relay preset for 150 ppm.
20. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180- degree field of view with vertical sensing adjustment, for flush mounting.
21. Gateways and Direct LAN Connections: Coordinate with HVAC equipment manufacturers, provide and install a complete and operational control Gateway and or Direct LAN connection to the HVAC equipment. Coordinate with equipment manufacturers and other trades to avoid omission or duplication and assure a complete and operating system.
22. Room Temperature Sensor: White, with concealed thermometer and override switch. Install on a sealed airtight insulated backing base.
23. kW Meter: Microprocessor based power transducer with high accuracy split-core current transformers for 3-phase, 208-480 Vac, 60 Hz power measurement. Provide 4 to 20 mA, 0-10 VDC, or pulsed digital output signal. Coordinate with electrical contractor and the manufacturers of HVAC equipment.

B. Switches and sensors applications:

1. Status Inputs for Fans: Current sensing relay.
2. Status Inputs for Pumps: Current sensing relay.
3. Status Inputs for other Electric Motors: Current-sensing relay.
4. Duct Temperature Sensors: 1000 Ohm RTD Duct Sensors with operating range of 20 degrees F to 120 degrees F.
5. Room Temperature Sensors: Thermistor to 55-95 degrees F with 0.5 degrees F accuracy.
6. Chilled Water Pipe Temperature Sensors: 1000 Ohm RTD Liquid Immersion Sensors with operating range 20 degrees F to 70 degrees F.
7. Hot Water Pipe Temperature Sensors: 1000 Ohm RTD Liquid Immersion Sensors with operating range of 30 degrees F to 250 degrees F.
8. Provide and install all other components indicated for complete and operational system.

## 2.08 ROOM TEMPERATURE AND CO2 SENSORS

- A. Provide room sensor with integrated CO2 sensing for zones with DCV (refer to VAV schedule).
- B. CO2 sensors shall be certified by the manufacturer to have an accuracy of 400-1250 ppm  $\pm$ 30 ppm or 3% of reading (whichever is greater), factory calibrated or calibrated at start-up,

and certified by the manufacturer to require calibration no more frequently than once every 5 years.

C. Room sensors are to be provided with a cover to prevent accidental damage.

1. Operating Temperature -40 to 240°F
2. CO2 measuring range 0 to 2000 ppm
3. Operating Range, Active Signal Types 40 to 90°F
4. Temperature Effect Less than 0.1% per °C
5. Sensing Element NTC 10K (Type II) Thermistor
6. Accuracy at Calibration Temperature +/- 1 °F

## 2.09 CURRENT TRANSFORMERS

- A. The current transformers shall be provided to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.
- B. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.
- C. The current transformers shall meet the following specifications.
  1. Frequency Limits: 50 to 400 Hz.
  2. Insulation: 0.6 KV Class, 10 KV BIL.
  3. Accuracy:  $\pm 1\%$  at 5.0 to 25.0 VA accuracy class with U.P.F. burden.
  4. Provide a disconnect switch for each current transformer.

## 2.10 CURRENT SENSING SWITCHES

- A. Current sensing switch shall be self-powered with solid-state circuitry and a dry contact output.
- B. Current sensing switches shall consist of a solid-state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over current up to twice its trip into range.

## 2.11 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

- A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
- B. Position indicator and graduated scale on each actuator.
- C. Type: Motor operated, with or without gears, electric and electronic.
- D. Voltage: 24 VAC or 120 VAC.
- E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
- F. Function properly within a range of 85 to 120 percent of nameplate voltage.
- G. Construction:
  1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
  2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.



3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

H. Field Adjustment:

1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

I. Two-Position Actuators: Single direction, spring return or reversing type.

J. Modulating Actuators:

1. Operation: Capable of stopping at all points across full range and starting in either direction from any point in range.
2. Control Input Signal:
  - i. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and/or 4- to 20-mA signals.
  - ii. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
  - iii. Programmable Multi-Function:
    - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
    - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
    - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

2.12 BALL VALVES WITH SINGLE PORT AND CHARACTERIZED DISC

A. Manufacturers:

1. Belimo
2. Bray

B. Pressure Rating for NPS 1 (DN 25) and Smaller: Nominal 600 WOG.

C. Pressure Rating for NPS 1-1/2 (DN 38) through NPS 2 (DN 50): Nominal 400 WOG.

D. Close-off Pressure: 200 psig (1379 kPa).

E. Process Temperature Range: Zero to 212 deg F (Minus 18 to plus 100 deg C).

F. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.

G. End Connections: Threaded (NPT) ends.

H. Ball: Chrome-plated brass or bronze.

I. Stem and Stem Extension: Material to match ball.

J. Blowout-proof design.

K. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.

- L. Ball Seats: Reinforced PTFE.
- M. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
- N. Flow Characteristic: Equal percentage.

## 2.13 MOTORIZED BUTTERFLY VALVES

- A. Manufacturers:
  - 1. Belimo
  - 2. Bray
- B. Furnish automatic butterfly valves for isolation requirements as shown on the drawings or required herein. All butterfly valves shall have maximum close-off or differential pressure of 150 psig, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
- C. Body Style: Lug.
- D. Disc Type: Nickel-plated ductile iron.
- E. Motorized valves located outdoors or in areas subject to outdoor air conditions provide fail in place, electric operators with water-proof enclosure and open and closed position limit switches. Valve and all accessories shall be constructed for outdoor use. All electrical devices shall be weather-proof and NEMA 4 rated.
- F. All valves shall be provided with external position indicators and a speed control device to prevent rapid closure.
- G. The valves shall be line size as shown on plans.

## 2.14 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V:
  - 1. Wire size shall be at least No. 18 AWG.
  - 2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
  - 3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
  - 4. Conductor colors shall be black (hot), white (neutral), and green (ground).
  - 5. Furnish wire on spools.
- B. Single Twisted Shielded Instrumentation Cable above 24 V:
  - 1. Wire size shall be a minimum No. 22 AWG.
  - 2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
  - 3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
  - 4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
  - 5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
  - 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.

7. Furnish wire on spools.
- C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
1. Wire size shall be a minimum No. 22 AWG.
  2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
  3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
  4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
  5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
  6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
  7. Furnish wire on spools.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
1. Cable shall be balanced twisted pair.
  2. Comply with the following requirements:
    - i. Cable shall be plenum rated.
    - ii. Cable shall have a unique color that is different from other cables used on Project.

## 2.15 RACEWAYS

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

## 2.16 IDENTIFICATION

### A. Instrument Air Pipe and Tubing:

1. Engraved tag shall bear the following information:
  - i. Service (Example): "Instrument Air."
  - ii. Pressure Range (Example): 0 to 30 psig.
2. Letter size shall be a minimum of 0.25 inch high.
3. Tag shall consist of white lettering on blue background.
4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded blue with contrasting white center exposed by engraving through outer layer.
5. Include tag with a brass grommet, chain, and S-hook.

### B. Control Equipment, Instruments, and Control Devices:

1. Self-adhesive label bearing unique identification.
  - i. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Legend shall consist of white lettering on black background.

3. Laminated acrylic or melamine plastic sign shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer and shall be fastened with drive pins.
4. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

C. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tags shall be at least 1.5 inches in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

D. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.

E. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch beyond white border.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
  1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
  2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

#### A. Communication Interface to Equipment with Integral Controls:

- 1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
- 2. Equipment to Be Connected:
  - i. Air-terminal units specified in Section 233600 "Air Terminal Units."
  - ii. Boilers specified in Section 235216 "Condensing Boilers."
  - iii. Chillers specified in Section 236426.13 "Air-Cooled, Rotary-Screw Water Chillers."
  - iv. Variable-frequency drives specified in Section 230549 "Variable-Frequency Drives."
  - v. Engine generators specified in Section 263213 "Engine Generators."

### 3.03 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

#### A. Interface with Existing Systems:

- 1. DDC systems shall interface existing systems to achieve integration.
- 2. Integration of Existing Control System into DDC System:
  - i. Existing control system performance requirements shall be satisfied when monitoring and controlling existing control system through DDC system.
  - ii. Operator shall be able to upload, download, monitor, alarm, report, trend, control and program every input and output point in existing system from DDC system using operator workstations and software provided. The combined systems shall share one database.
  - iii. Interface of existing control system I/O points into DDC system shall be transparent to operators. All operational capabilities shall be identical regardless of whether I/O already exists or I/O is being installed.

### 3.04 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
  - 1. DDC control valves.
  - 2. Pipe-mounted flow meters.
  - 3. Pipe-mounted sensors, switches, and transmitters.
  - 4. Tank-mounted sensors, switches, and transmitters.
  - 5. Pipe- and tank-mounted thermowells

### 3.05 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment where required.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop penetrations made in fire-rated assemblies.
- G. Seal penetrations made in acoustically rated assemblies.
- H. Welding Requirements:
  - 1. Restrict welding and burning to supports and bracing.
  - 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
  - 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
  - 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

### 3.06 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections.
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.
- E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

### 3.07 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.
- B. Install self-adhesive labels with unique identification on face for each of the following:
  - 1. Operator workstation.
  - 2. Server.
  - 3. Printer.
  - 4. Gateway.
  - 5. Router.
  - 6. Protocol analyzer.
  - 7. DDC controller.
  - 8. Enclosure.
  - 9. Electrical power device.
  - 10. UPS unit.
  - 11. Accessory.
- C. Install unique instrument identification on face of each instrument connected to a DDC controller.
- D. Install unique identification on face of each control damper and valve actuator connected to a DDC controller.
- E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.
- F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.
- G. Warning Labels and Signs:
  - 1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
  - 2. Shall be located in highly visible location near power service entry points.

### 3.08 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.
- B. ASHRAE 135 Networks:
  - 1. MAC Address:
    - i. Every network device shall have an assigned and documented MAC address unique to its network.
    - ii. Ethernet Networks: Document MAC address assigned at its creation.
    - iii. ARCNET or MS/TP networks: Assign from 00 to 64.
  - 2. Network Numbering:
    - i. Assign unique numbers to each new network.
    - ii. Provide ability for changing network number through device switches or operator interface.

- iii.DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
- 3. Device Object Identifier Property Number:
  - i. Assign unique device object identifier property numbers or device instances for each device network.
  - ii. Provide for future modification of device instance number by device switches or operator interface.
  - iii.LAN shall support up to 4,194,302 unique devices.
- 4. Device Object Name Property Text:
  - i. Device object name property field shall support 32 minimum printable characters.
  - ii. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
    - 1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
    - 2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".
- 5. Object Name Property Text for Other Than Device Objects:
  - i. Object name property field shall support 32 minimum printable characters.
  - ii. Assign object name properties with plain-English names descriptive of application.
    - 1) Example 1: "Zone 1 Temperature."
    - 2) Example 2 "Fan Start and Stop."
- 6. Object Identifier Property Number for Other Than Device Objects:
  - i. Assign object identifier property numbers according to Drawings indicated.
  - ii. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

### 3.09 PIPING AND TUBING INSTALLATION

#### A. Above-Grade Pneumatic and Air Signal Piping and Tubing Installation:

##### 1. Material Application:

- i. Install copper tubing, except as follows:
  - 1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.
  - 2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when [concealed behind accessible ceilings] [and] [concealed in walls and connecting wall-mounted instruments with recessed connections].
- ii. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
- iii. Install barbed or compression fittings to connect polyethylene tubing to instruments, control devices, and accessories.



### 3.10 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
  - i. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
2. Terminate wiring in a junction box.
  - i. Clamp cable over jacket in junction box.
  - ii. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
3. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
4. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
5. Use shielded cable to transmitters.
6. Use shielded cable to temperature sensors.
7. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section "260533 "Raceways and Boxes for Electrical Systems" for control-voltage conductors.

### 3.11 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Testing of Pneumatic and Air-Signal Tubing:
  - i. Test for leaks and obstructions.
  - ii. Disconnect each pipe and tubing line before a test is performed, and blowout dust, dirt, trash, condensate and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Air from an oil-free compressor with an air dryer is an acceptable alternative for the test.
  - iii. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
  - iv. Connect a pressure source to near end of run with a needle valve between air supply and tubing run.
  - v. Connect a pressure gage accurate to within 0.5 percent of test between the shutoff needle valve and tubing run under test.

- vi. For system pressures above 30 psig, apply a pressure of 1.5 times operating pressure. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 1 psig.
- vii. For system pressures 30 psig and below, apply a pressure of 2.0 times operating pressure to piping and tubing run. Record pressure in tubing run every 5 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 0.5 psig.

B. Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.12 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
- E. For pneumatic products, verify that air supply for each product is properly installed.
- F. Control Damper Checkout:
  1. Verify that control dampers are installed correctly for flow direction.
  2. Verify that proper blade alignment, either parallel or opposed, has been provided.
  3. Verify that damper frame attachment is properly secured and sealed.
  4. Verify that damper actuator and linkage attachment is secure.
  5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
  6. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. Verify that control valves are installed correctly for flow direction.
2. Verify that valve body attachment is properly secured and sealed.
3. Verify that valve actuator and linkage attachment is secure.
4. Verify that actuator wiring is complete, enclosed and connected to correct power source.
5. Verify that valve ball, disc or plug travel is unobstructed.
6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:
  - i. Verify sensing element type and proper material.
  - ii. Verify length and insertion.

3.13 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.

- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
  2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
  3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
1. Check digital signals using a jumper wire.
  2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:
1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
  2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
  3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
  4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- M. Control Valves:
1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
  2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
  3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
  4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.
- O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
- P. Switches: Calibrate switches to make or break contact at set points indicated.
- Q. Transmitters:
1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
  2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

### 3.14 DDC SYSTEM CONTROLLER CHECKOUT

- A. Verify power supply.
  - 1. Verify voltage, phase and hertz.
  - 2. Verify that protection from power surges is installed and functioning.
  - 3. Verify that ground fault protection is installed.
  - 4. If applicable, verify if connected to UPS unit.
  - 5. If applicable, verify if connected to a backup power source.
  - 6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.
- B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.
- C. Verify that spare I/O capacity is provided.

### 3.15 DDC CONTROLLER I/O CONTROL LOOP TESTS

- A. Testing:
  - 1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
  - 2. Test every I/O point throughout its full operating range.
  - 3. Test every control loop to verify operation is stable and accurate.
  - 4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
  - 5. Test and adjust every control loop for proper operation according to sequence of operation.
  - 6. Test software and hardware interlocks for proper operation. Correct deficiencies.
  - 7. Operate each analog point at the following:
    - i. Upper quarter of range.
    - ii. Lower quarter of range.
    - iii. At midpoint of range.
  - 8. Exercise each binary point.
  - 9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
  - 10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

### 3.16 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.

- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
1. Detailed explanation for any items that are not completed or verified.
  2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
  3. HVAC equipment motors operate below full-load amperage ratings.
  4. Required DDC system components, wiring, and accessories are installed.
  5. Installed DDC system architecture matches approved Drawings.
  6. Control electric power circuits operate at proper voltage and are free from faults.
  7. Required surge protection is installed.
  8. DDC system network communications function properly, including uploading and downloading programming changes.
  9. Using BACnet protocol analyzer, verify that communications are error free.
  10. Each controller's programming is backed up.
  11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
  12. All I/O points are programmed into controllers.
  13. Testing, adjusting and balancing work affecting controls is complete.
  14. Dampers and actuators zero and span adjustments are set properly.
  15. Each control damper and actuator goes to failed position on loss of power.
  16. Valves and actuators zero and span adjustments are set properly.
  17. Each control valve and actuator goes to failed position on loss of power.
  18. Meter, sensor and transmitter readings are accurate and calibrated.
  19. Control loops are tuned for smooth and stable operation.
  20. View trend data where applicable.
  21. Each controller works properly in standalone mode.
  22. Safety controls and devices function properly.
  23. Interfaces with fire-alarm system function properly.
  24. Electrical interlocks function properly.
  25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
  26. Record Drawings are completed.
- E. Test Plan:
1. Prepare and submit a validation test plan including test procedures for performance validation tests.
  2. Test plan shall address all specified functions of DDC system and sequences of operation.
  3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.

4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 10 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
  - i. Verify analog I/O points at operating value.
  - ii. Make adjustments to out-of-tolerance I/O points.
    - 1) Identify I/O points for future reference.
    - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
    - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:
  - i. Re-check I/O points that required corrections during initial test.
  - ii. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
  - i. Re-check I/O points that required corrections during second test.
  - ii. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.
  - i. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:
  - i. Reaction to COV and alarm conditions during HLC.
  - ii. Ability to update DDC system database during HLC.

5. Passing test is contingent on the following:
  - i. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
  - ii. All alarms, both binary and analog, are reported and printed; none are lost.
  - iii. Compliance with response times specified.
6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.17 DDC SYSTEM WIRELESS NETWORK VERIFICATION

- A. DDC system Installer shall design wireless DDC system networks to comply with performance requirements indicated.
- B. Installer shall verify wireless network performance through field testing and shall document results in a field test report.
- C. Testing and verification of all wireless devices shall include, but not be limited to, the following:
  1. Speed.
  2. Online status.
  3. Signal strength.

3.18 FINAL REVIEW

- A. Submit written request to Architect and Owner's Representative when DDC system is ready for final review. Written request shall state the following:
  1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
  2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
  3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
  4. DDC system is complete and ready for final review.
- B. Review by Architect and Owner's Representative shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor, and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.



- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. A part of DDC system final review shall include a demonstration to parties participating in final review.
1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
  2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
  3. Demonstration shall include, but not be limited to, the following:
    - i. Accuracy and calibration of 20 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
    - ii. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 20 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
    - iii. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
    - iv. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
    - v. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
    - vi. Trends, summaries, logs and reports set-up for Project.
    - vii. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
    - viii. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
    - ix. Software's ability to edit control programs off-line.
    - x. Data entry to show Project-specific customizing capability including parameter changes.
    - xi. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
    - xii. Execution of digital and analog commands in graphic mode.
    - xiii. Spreadsheet and curve plot software and its integration with database.
    - xiv. Online user guide and help functions.
    - xv. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
    - xvi. System speed of response compared to requirements indicated.

xvii. For Each Network and Programmable Application Controller:

- 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
- 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
- 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
- 4) Electric Power: Ability to disconnect any controller safely from its power source.
- 5) Wiring Labels: Match control drawings.
- 6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
- 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.

xviii. For Each Operator Workstation:

- 1) I/O points lists agree with naming conventions.
- 2) Graphics are complete.
- 3) UPS unit, if applicable, operates.

xix. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's equipment is installed.

- 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
- 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
- 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. [Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.]
- 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
- 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
- 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.

- 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
- 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
- 9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
- 10) Device and Network Management:
  - a) Display of network device status.
  - b) Display of BACnet Object Information.
  - c) Silencing devices transmitting erroneous data.
  - d) Time synchronization.
  - e) Remote device re-initialization.
  - f) Backup and restore network device programming and master database(s).
  - g) Configuration management of routers.

### 3.19 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.20 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

### 3.21 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:
  1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
  2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
  3. Minimum Training Requirements:

- i. Provide not less than five days of training total.
- ii. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
- iii. Total days of training shall be broken into not more than two separate training classes.
- iv. Each training class shall be not less than one consecutive days.

C. Training Schedule:

1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least 10 business days of notice in advance of training.
3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with a break between sessions. Morning and afternoon sessions shall be separated by a lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.

E. Training Attendee Headcount:

1. Coordinate with Owner in advance for anticipated number of training attendees.
2. Make allowance for Owner to add up to two attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.

3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

G. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have not less than [five] years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

H. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
  - i. Daily operators.
  - ii. Advanced operators.
  - iii. System managers and administrators.
2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

I. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

J. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

K. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide a workstation for use by each attendee.

L. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers, and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports, and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
  - i. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
  - ii. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.

- iii. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
- iv. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
- v. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
- vi. Each control loop responds to set point adjustment and stabilizes within time period indicated.
- vii. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

M. Video of Training Sessions:

1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
2. Stamp each recording file with training session number, session name and date.
3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

**END OF SECTION**

## SECTION 23 09 93

### SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment. Refer to the controls portion of this Specification and the Drawings for a complete understanding of the control sequences. Contractor shall be responsible for coordinating Division 230900 and service representatives of the equipment manufacturers to implement these control sequences along with Division 26. Prior to providing submittals, all field wiring connections shall be determined and shown on the submittals for electrical and controls interface.
- B. Related Sections include the following:
  - 1. Section 230900 "Direct Digital Control for HVAC" for control equipment and devices and for submittal requirements.
- C. Definitions
  - 1. AHU: Air handler.
  - 2. CHW: Chilled water.
  - 3. CV: Control valve.
  - 4. DDC: Direct digital control.
  - 5. DP: Differential pressure sensor.
  - 6. EMS: Energy management system.
  - 7. GUI: Graphical user interface.
  - 8. HHW: Heating hot water.
  - 9. OSA: Outside Air
  - 10. PSID: Pounds per square inch differential.
  - 11. RAT: Return Air Temperature
  - 12. SAT: Supply Air Temperature
  - 13. VAV: Variable air volume.
  - 14. VFD: Variable frequency drive.

##### 1.03 SEQUENCE OF OPERATIONS

- A. General:
  - 1. All set-points, time intervals and schedules shall be adjustable through the Graphical User Interface (GUI), unless noted otherwise.
  - 2. Prior to implementing the sequence of operation, the Controls Contractor shall be fully responsible to coordinate a meeting with the programmer, College maintenance staff and the Engineer of Record to insure that the functional blocks, control hardware and accessories are programmed correctly and virtually tested.



## B. Trim and Respond Logic

1. Trim and respond setpoint reset logic and zone/system reset requests, where referenced in sequences, shall be implemented as described below.
2. A "request" is a call to reset a static pressure or temperature setpoint generated by downstream zones or air handling systems. These requests are sent upstream to the plant or system that serves the zone or air handler that generated the request.
  - i. For each downstream zone or system, and for each type of setpoint reset request listed for the zone/system, provide the following software points:
    - 1) Importance-Multiplier (default = 1).
    - 2) Request-Hours Accumulator. Every x minutes (default 5 minutes), add x divided by 60 times the current number of requests to this request-hours accumulator point.
    - 3) System Run-Hours Total. This is the number of hours the zone/system has been operating in any mode other than Unoccupied Mode.
    - 4) Cumulative%-Request-Hours. This is the zone/system request-hours divided by the zone/system run-hours (the hours in any mode other than unoccupied mode) since the last reset, expressed as a percentage.
    - 5) The Request-Hours Accumulator and System Run-Hours Total are reset to zero as follows:
      - a) Reset automatically for an individual zone/system when the System Run-Hours Total exceeds 400 hours.
      - b) Reset manually by a global operator command. This command will simultaneously reset the Request-Hours point for all zones served by the system.
    - 6) A Level 4 alarm is generated if the zone Importance-Multiplier is greater than zero, the zone/system Cumulative% Request Hours exceeds 70%, and the total number of zone/system run hours exceeds 40.
  - ii. See zone and air-handling system control sequences for logic to generate requests.
  - iii. Multiply the number of requests determined from zone/system logic times the Importance Multiplier and send to the system/plant that serves the zone/system. See system/plant logic to see how requests are used in trim and respond logic.
3. For each upstream system or plant setpoint being controlled by a trim and respond loop, define the following variables. Initial values are defined in system/plant sequences below. Values for trim, respond, time step, etc. shall be tuned to provide stable control.

Variable	Definition
Device	Associated device (e.g. fan, pump)
SP <sub>0</sub>	Initial setpoint
SP <sub>min</sub>	Minimum setpoint
SP <sub>max</sub>	Maximum setpoint
T <sub>d</sub>	Delay timer
T	Time step
I	Number of ignored requests
R	Number of requests from zones/systems
SP <sub>trim</sub>	Trim amount
SP <sub>res</sub>	Respond amount (must be opposite in sign to SP <sub>trim</sub> )
SP <sub>res-max</sub>	Maximum response per time interval (must be same sign as SP <sub>res</sub> )

4. Trim and respond logic shall reset the setpoint within the range SP<sub>min</sub> to SP<sub>max</sub>. When the associated device is off, the setpoint shall be SP<sub>0</sub>. The reset logic shall be active while the associated device is proven on, starting T<sub>d</sub> after initial device start command. When active, every time step T, if R ≤ I, trim the setpoint by SP<sub>trim</sub>. If there are more than I requests, respond by changing the setpoint by SP<sub>res</sub>\*(R – I), (i.e., the number of requests minus the number of ignored requests) but no more than SP<sub>res-max</sub>. In other words, every time step T:
  - i. If R ≤ I, change Setpoint by SP<sub>trim</sub>
  - ii. If R > I, change setpoint by (R – I)\*SP<sub>res</sub> but no larger than SP<sub>res-max</sub>

#### C. MULTIPLE-ZONE AIR HANDLING UNIT, AHU-1, AHU-2, AHU-3

1. Sequence of Operations
2. The occupancy mode (Occupied or Unoccupied) shall be determined through a user-adjustable, graphical, seven-day schedule with a holiday schedule.
3. Whenever the supply fan is de-energized, as sensed by the status switch, the return fan shall be de-energized, the outside and exhaust air dampers shall be closed and the return air damper shall be open, the heating and cooling valves shall be closed or positioned as described below.
4. Space purge and warm-up or cool-down
  - i. 1 hour before scheduled occupancy all AHUs shall purge the space:
    - 1) Set all space/room temperatures set points for 68°F for heating and 75°F for cooling.
    - 2) Set all spaces/rooms to occupied mode.
    - 3) Set economizer and minimum OSA dampers for full open.
    - 4) Ignore CO<sub>2</sub> inputs for demand control ventilation.
    - 5) Set return damper to closed, set relief damper to open.
    - 6) Modulate supply fan speed to supply so that at least one VAV box is at 90% open or greater and the supply air flow rate is greater than the OSA minimum set point.
    - 7) If at least three (3) zones are calling for cooling, then enable the CH-1 system (as noted in the chiller articles).

- 8) Modulate the CHW control valves to cool the supply air temperature to 53°F.
- 9) CH-1 and CHW valves shall be locked out when space requires heating during purge cycle.
- 10) At the completion of the purge cycle, release space/room temperature set points to user set temperatures and put the AHUs in normal operations.

#### 5. Occupied Mode

- i. Supply fan shall run when system is in the space purge mode, cool-down mode, warm-up mode, or occupied mode.
- ii. Totalize current airflow rate from VAV boxes to a software point visible through the BMS for display and diagnostics.

#### 6. Static Pressure Setpoint Reset

- i. Static pressure setpoint shall be reset using trim and respond logic using the following parameters:

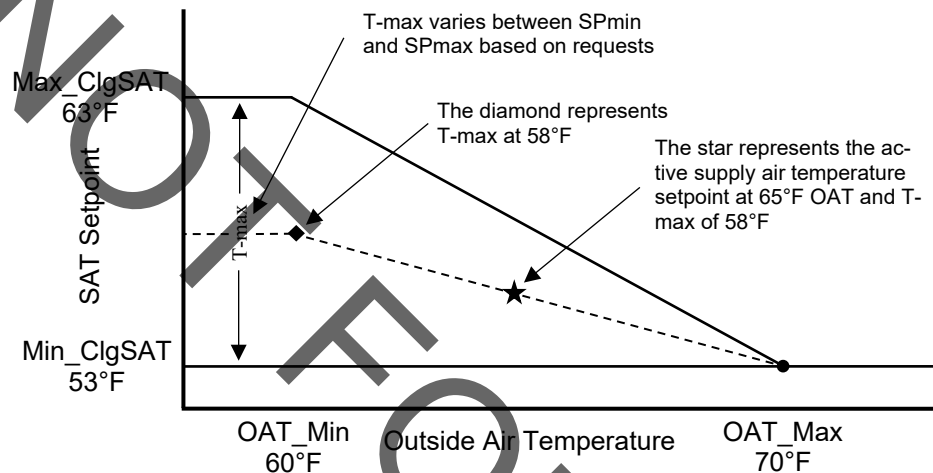
Variable	Value
Device	Supply fan
SP <sub>0</sub>	0.5 in. of water
SP <sub>min</sub>	0.1 in. of water
SP <sub>max</sub>	Max DSP
T <sub>d</sub>	10 minutes
T	2 minutes
I	2
R	Zone static pressure reset requests
SP <sub>trim</sub>	-0.05 in. of water
SP <sub>res</sub>	+0.06 in. of water
SP <sub>res-max</sub>	+0.13 in. of water

- ii. Supply fan speed is controlled to maintain DSP at setpoint when the fan is proven on.

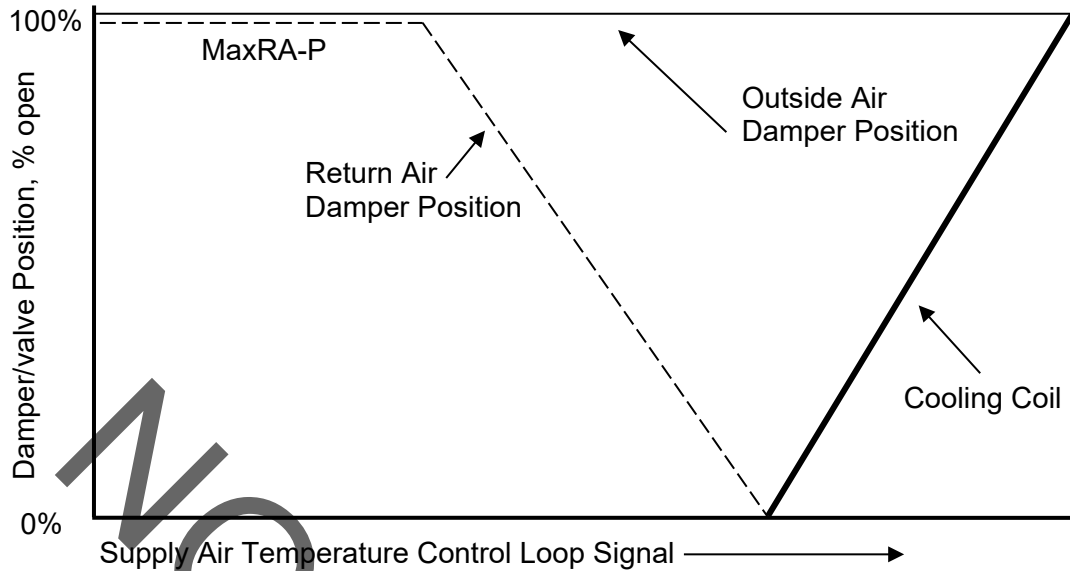
#### 7. Supply Air Temperature Control

- i. Control loop is enabled when the supply air fan is proven on, and disabled and output set to deadband (no heating, minimum economizer) otherwise.
- ii. Supply Air Temperature Setpoint
  - 1) During occupied mode and purge mode, setpoint shall be reset from 53°F (adjustable) when the outside air temperature is 70°F and above, proportionally up to 63°F (adjustable) when the outside air temperature is 60°F and below.
    - a) T-max shall be reset using trim and respond logic between 53°F and 63°F. The parameters shown below are suggested as a starting place, but they will require adjustment during the commissioning and tuning phase.

Variable	Value
Device	Supply fan
SP <sub>0</sub>	Max_ClgSAT (63°F)
SP <sub>min</sub>	Min_ClgSAT (53°F)
SP <sub>max</sub>	Max_ClgSAT (63°F)
T <sub>d</sub>	10 minutes
T	2 minutes
I	2
R	Zone cooling SAT requests
SP <sub>trim</sub>	+0.2°F
SP <sub>res</sub>	-0.3°F
SP <sub>res-max</sub>	-1.0°F

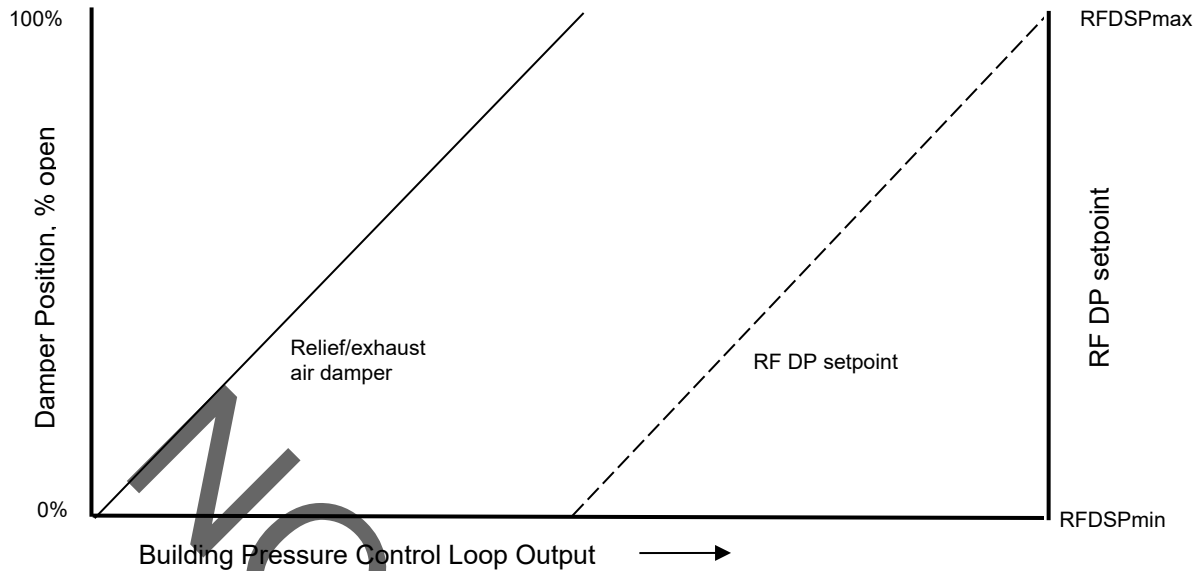


- 2) During Cooldown Mode, setpoint shall be Min\_ClgSAT.
  - 3) During Warmup Mode and Setback Mode, setpoint shall be 95°F.
- iii. Supply air temperature shall be controlled to setpoint using a control loop whose output is mapped to sequence outside air damper, return air damper, and cooling coil as shown below.
- 1) Return air damper maximum position MaxRA-P is modulated to control minimum outside air volume.
  - 2) The points of transition along the x-axis shown and described below are representative. Separate gains shall be provided for each section of the control map (return air damper, outside air damper, cooling coil) that is determined by the contractor to provide stable control. Alternatively, the contractor shall adjust the precise value of the x-axis thresholds to provide stable control.



#### 8. Building Static Pressure Control

- i. The return fan operates whenever the associated supply fan is proven on and shall be off otherwise.
- ii. Return fans shall be controlled to maintain return fan discharge static pressure at setpoint.
- iii. Building static pressure shall be time averaged with a slide 5-minute window and 15 second sampling rate. The averaged value shall be that displayed and used for control.
- iv. A single P-only control loop shall modulate to maintain the building pressure at a setpoint of 0.05 in. of water with an output ranging from 0% to 100%. The loop shall be enabled when the supply and return fans are proven on and the outside air damper is open. The exhaust dampers shall be closed with loop output set to zero otherwise. All exhaust damper and return fan static pressure setpoints shall be sequenced based on building pressure control loop output signal. To prevent excessive control loop interaction, the closed loop response time of the building pressurization loop should not exceed 1/5 the closed loop response time of the return fan control loop.
  - 1) From 0% to 50%, the building pressure control loop shall modulate the exhaust damper from 0% to 100% open
  - 2) From 51% to 100%, the building pressure control loop shall reset the return-fan discharge static pressure setpoint from RFDSPmin at 50% loop output to RFDSPmax at 100% of loop output, as determined below:
    - a) RFDSPmin. That required to deliver the design return air volume across the return air damper when the supply air fan is at design airflow and on minimum outside air. This setpoint shall be no less 0.01 in. of water to ensure outside air is not drawn backwards through the relief damper.
    - b) RFDSPmax. That required to exhaust enough air to maintain building static pressure at setpoint 0.05 in. of water when the supply air fan is at design airflow and on 100% outside air.



#### 9. Minimum Outside Air Control

##### i. Outside Airflow Setpoints.

- 1) Refer to AHU schedule on M002 for outside air setpoints DCV OSA and Min OSA for each unit.
- 2) See zone CO<sub>2</sub> control logic under VAV box sequences.
- 3) The minimum outside air setpoint shall be reset based on the highest zone CO<sub>2</sub> control-loop signal from DCV OSA at 50% signal to Min OSA at 100% signal.

##### ii. Minimum Outside Air Control Loop

- 1) Minimum outside air control loop is enabled when the supply fan is proven on and the AHU is in occupied mode, and disabled and output set to zero otherwise.
- 2) The outside airflow rate shall be maintained at the minimum outside damper outside airflow setpoint by a direct-acting control loop whose output is mapped to the return air damper maximum position endpoint MaxRA-P.

#### 10. Economizer Control

- i. Each AHU air economizer shall operate based on differential dry bulb high limit control.
- ii. Economizer shall be disabled whenever the outside air dry bulb temperature exceeds return air dry bulb temperature by 2°F or more.

#### 11. Demand Control Ventilation

- i. Refer to VAV Box sequence of operations for room CO<sub>2</sub> setpoints.
- ii. During occupied mode, if the DCV loop output of all zones with CO<sub>2</sub> sensors is 0-50%, the AHU shall maintain the minimum outside air setpoint DCV OSA as indicated on M002.

- iii. The minimum outside air setpoint shall be reset based on the highest zone CO2 control loop signal from DCV OSA at 50% signal up to Min OSA at 100% signal as indicated on M002.

#### 12. Filter Alarm

- i. Monitor pressure drop across filters and trigger an alarm if the filter pressure drop exceeds 0.8" WC at design supply air CFM.
- ii. The alarm shall vary with fan speed roughly as follows:
  - 1)  $DP_x = DP_{100}(x)1.4$
- iii. Where DP100 is the high limit pressure drop (0.8" WC) at design cfm and DPx is the high limit at speed (IGV) signal x (expressed as a fraction of full signal). For instance, the setpoint at 50% of full speed would be (0.5)1.4 or 38% of the design high limit pressure drop.

#### 13. Unoccupied Mode

- i. Unoccupied Off: The supply and return fans shall be de-energized. Outside air dampers and exhaust dampers shall be closed and return air damper open.

#### 14. Safety Shutdowns

- i. Duct smoke detection, space smoke detection, high pressure safeties, low pressure safeties and low temperature limit trips shall de-energize the air handling unit and close the outside air and exhaust air dampers. Manual reset of the tripped device shall be required to restart the system.
- ii. Smoke Detector
  - 1) Whenever smoke detector triggered:
    - a) Turn off supply and return fans
    - b) Close CHW valve
- iii. Alarm BAS operator CO2 Sensor Failure
  - 1) If a CO2 sensor fails, reset AHU OSA minimum set point to the Min OSA CFM as shown on M002.
  - 2) Alarm BAS operator.
- iv. Whenever the supply air temperature is below 52°F for 10 minutes or above 90°F alarm the BAS operator.

### D. SPLIT SYSTEMS, FC/CU

#### 1. Sequence of Operations

- i. The FC/CU units shall be energized 24hrs/7days a week.
- ii. The FC/CU shall be scheduled to be off during occupied hours.
- iii. All units shall have a programmable, digital thermostat.
- iv. All units are controlled by programmable thermostats and are not controlled by the BAS.

#### 2. Temperature Setpoints

- i. Cooling 75°F (adjustable)

#### 3. Back-Up Cooling Mode

- i. During occupied hours, if the zone that is equipped with the FC/CU is 78°F or higher for at least 10 minutes (adj.), the FC/CU serving that zone shall be

enabled and its associated VAV box shall have its airflow setpoint reset to the zone minimum airflow.

- ii. The FC/CU shall be disabled when the zone temperature reaches 72°F. The VAV box airflow control shall return to occupied mode.

4. Temperature alarms

- i. Spaces equipped with the split systems shall have a separate thermostat for the VAV box serving that room tied into the BMS.
- ii. Whenever the space temperature is above 80°F, then alarm BMS operator.

E. VAV BOX CONTROL (Reheat, Dual Maximum Without Demand Controlled Ventilation)

1. Space shall be capable of being scheduled on/off through the control system as required in the Sequence. When the space is scheduled off, the corresponding VAV box damper(s) shall be fully closed.
2. Each zone shall have a cooling set-point and heating set-point. The temperature between these two set-points is the dead-band.
3. When the zone is in the cooling mode, the cooling loop output is mapped to the airflow set-point from the cooling maximum to the minimum airflow set-points. The hot water valve is closed.
4. When the zone is in the dead-band mode, the airflow set-point shall be the minimum airflow set-point. The hot water valve is closed.
5. When the zone is in the heating mode, the heating loop shall maintain space temperature at the heating set-point as follows:
  - i. From 0%-50% loop signal, the heating loop output shall reset the discharge temperature from supply air temperature set-point (e.g., 55°F) to 85°F. Note the upper temperature is limited to prevent stratification during heating.
  - ii. From 50%-100% loop signal, the heating loop output shall reset the zone airflow set-point from the minimum airflow set-point to the maximum heating airflow set-point. The supply air discharge temperature remains at 85°F.
  - iii. The hot water valve shall be modulated using a PI control loop to maintain the discharge temperature at set-point. Note that directly controlling the hot water valve from the zone temperature PI loop is not acceptable since it will not allow supply air temperature to be under control and limited in temperature to prevent stratification.
  - iv. The VAV damper shall be modulated to maintain the measured airflow at set-point.
6. For zones that have occupant-sensing controls:
  - i. When the occupancy sensor(s) indicate that all rooms in the zone have been unpopulated for 5 minutes continuously during the occupied mode, the active heating setpoint shall be decreased by 1°F and the cooling setpoint shall be increased by 1°F. All airflow to the zone shall be shut off whenever the space temperature is between the active heating and cooling setpoints.
  - ii. When the occupancy sensor(s) indicate that any room in the zone has been populated for 1 minute continuously, the active heating and cooling setpoints shall be restored to their previous values.



#### F. VAV BOX CONTROL (Reheat, Dual Maximum With Demand Controlled Ventilation)

1. Space shall be capable of being scheduled on/off through the control system as required in the Sequence. When the space is scheduled off, the corresponding VAV box damper(s) shall be fully closed.
2. Each zone shall have a cooling set-point and heating set-point. The temperature between these two set-points is the dead-band.
3. When the zone is in the cooling mode, the cooling loop output is mapped to the airflow set-point from the cooling maximum to the minimum airflow set-points. The hot water valve is closed.
4. When the zone is in the dead-band mode, the airflow set-point shall be the minimum airflow set-point. The hot water valve is closed.
5. When the zone is in the heating mode, the heating loop shall maintain space temperature at the heating set-point as follows:
  - i. From 0%-50% loop signal, the heating loop output shall reset the discharge temperature from supply air temperature set-point (e.g., 55°F) to 85°F. Note the upper temperature is limited to prevent stratification during heating.
  - ii. From 50%-100% loop signal, the heating loop output shall reset the zone airflow set-point from the minimum airflow set-point to the maximum heating airflow set-point. The supply air discharge temperature remains at 85°F.
  - iii. The hot water valve shall be modulated using a PI control loop to maintain the discharge temperature at set-point. Note that directly controlling the hot water valve from the zone temperature PI loop is not acceptable since it will not allow supply air temperature to be under control and limited in temperature to prevent stratification.
  - iv. The VAV damper shall be modulated to maintain the measured airflow at set-point.
6. A proportional-only control loop shall maintain CO<sub>2</sub> concentration at 1,000 ppm. The output of this loop (0 to 100%) shall be mapped as follows: The loop output from 0 to 50% shall reset the minimum airflow set-point to the zone from the design minimum up to the maximum cooling airflow set-point. The loop output from 50% to 100% will be used at the system level to reset outside air minimum. Refer to Demand Control Ventilation Sequence for multi-zone air handling units.
7. For zones that have occupant-sensing controls:
  - i. When the occupancy sensor(s) indicate that all rooms in the zone have been unpopulated for 5 minutes continuously during the occupied mode, the active heating setpoint shall be decreased by 1°F and the cooling setpoint shall be increased by 1°F. All airflow to the zone shall be shut off whenever the space temperature is between the active heating and cooling setpoints.
  - ii. When the occupancy sensor(s) indicate that any room in the zone has been populated for 1 minute continuously, the active heating and cooling setpoints shall be restored to their previous values.

#### G. VAV BOX CONTROL (Cooling Only, Without Demand Controlled Ventilation)

1. Space shall be capable of being scheduled on/off through the control system as required in the Sequence. When the space is scheduled off, the corresponding VAV box damper(s) shall be fully closed.
2. Each zone shall have a cooling set-point.

3. When the zone is in the cooling mode, the cooling loop output is mapped to the airflow set-point from the cooling maximum to the minimum airflow set-points.
4. For zones that have occupant-sensing controls:
  - i. When the occupancy sensor(s) indicate that all rooms in the zone have been unpopulated for 5 minutes continuously during the occupied mode, the active heating setpoint shall be decreased by 1°F and the cooling setpoint shall be increased by 1°F. All airflow to the zone shall be shut off whenever the space temperature is between the active heating and cooling setpoints.
  - ii. When the occupancy sensor(s) indicate that any room in the zone has been populated for 1 minute continuously, the active heating and cooling setpoints shall be restored to their previous values.

#### H. Restroom Ventilation, General Exhaust Fans, EF-1, EF-2

1. The Direct Digital Control system (DDC) shall turn on and off, monitor, trend, and sequence as follows:
  - i. The exhaust fans shall operate whenever the building is in occupied mode.
  - ii. Status/alarm of fan operation shall be available through BMS.

#### I. Heating Hot Water System

##### 1. Boiler Plant Enable/Disable

- i. The boiler plant shall include an enabling schedule that allows operators to lock out the plant during off-hours, e.g. to allow off-hour operation of HVAC systems except the boiler plant. The default schedule shall be 24/7 (adjustable).
- ii. Enable the plant in the lowest stage when the plant has been disabled for at least 15 minutes and:
  - 1) Number of heating hot water plant requests > 5 (adj.), and
  - 2) OAT < boiler lockout temperature (default 75°F, adj.), and
  - 3) The boiler plant enable schedule is active.
- iii. Disable the plant when it has been enabled for at least 15 minutes and:
  - 1) Number of heating hot water plant requests ≤ 5 (adj.) for 3 minutes, or
  - 2) OAT > boiler lockout temperature (default 75°F, adj.) + 1°F, or
  - 3) The boiler plant enable schedule is inactive.
- iv. When the plant is enabled:
  - 1) Open the hot water isolation valve of the lead boiler.
  - 2) Stage on lead primary hot water pump per Section 1.03-G-2.
  - 3) Once the lead pump has proven on, enable the lead boiler.
- v. When the plant is disabled:
  - 1) Shut off the enabled boiler(s).
  - 2) For each enabled boiler, close the hot water isolation valve(s) after 3 minutes and disable the operating hot water pump(s) per Section 1.03-G-2.

##### 2. Heating Hot Water Pumps, HHWP-1 and HHWP-2

- i. Primary hot water pumps shall be lead/lag controlled.

ii. Enable lead primary hot water pump when any boiler isolation valve is commanded open. Disable the lead hot water pump when all boiler isolation valves are commanded closed.

iii. Hot water pumps shall be controlled by a DP sensor hardwired to the plant controller:

- 1) When any pump is proven on, pump speed shall be controlled by a reverse acting PID loop maintaining differential pressure at HW-DPmax. All pumps receive the same speed signal. PID loop output shall be mapped from minimum pump speed at 0% to maximum pump speed at 100%.
- 2) Primary hot water pump speed of all primary hot water pumps proven on shall be reset using trim & respond logic with the following parameters:

Variable	Value
Device	Any Primary pump proven on
SP <sub>0</sub>	100%
SP <sub>min</sub>	B-MinPriPumpSpdStage
SP <sub>max</sub>	100%
T <sub>d</sub>	15 minutes
T	2 minutes
I	0
R	Primary Pump Speed Reset Requests
SP <sub>trim</sub>	-2%
SP <sub>res</sub>	+3%
SP <sub>res-max</sub>	+6%

iv. Lag pump shall turn on when lead pump speed rises above 95% for 10 minutes(adj). Both pumps shall receive the same speed signal.

v. Lag pump shall turn off when speed of both pumps drops to 60% for 10 minutes (adj).

vi. Alternate lead/lag pump assignments weekly (adj.) to keep pump operating hour approximately equal.

vii. If the lead pump fails to start, start the lag pump, and alarm the BMS operator.

### 3. Boilers, B-1 and B-2

i. Boilers shall be lead/lag controlled.

ii. Whenever the lag boiler is enabled:

- 1) Open the lag boiler's hot water isolation valve.
- 2) After 30 seconds, enable the lag boiler.

iii. Whenever the lag boiler is disabled:

- 1) Disable the lag boiler.
- 2) After 3 minutes, close the lag boiler's isolation valve.

iv. The boilers have integral control logic for staging and capacity control and shall be monitored for enable/disable and status. All boilers are connected to

a multi-protocol communication gateway which will integrate between the boiler control system and the BMS.

- v. Alternate lead/lag boiler assignments weekly (adj.) so that the annual operating hours remains approximately equal.
- vi. If the lead boiler fails to start, start the lag boiler, and alarm the BAS operator.
- vii. If a boiler is in alarm, the boiler shall be disabled and after 3 minutes, its hot water isolation valve shall be closed.

#### 4. Hot Water Supply Temperature Reset

- i. Plant hot water supply temperature setpoint shall be reset using trim & respond logic with the following parameters:

Variable	Value
Device	Any HW Pump Distribution Loop
SP <sub>0</sub>	SP <sub>max</sub>
SP <sub>min</sub>	90°F
SP <sub>max</sub>	140°F
T <sub>d</sub>	10 minutes
T	5 minutes
I	2
R	Hot-Water Reset Requests
SP <sub>trim</sub>	-2°F
SP <sub>res</sub>	+3°F
SP <sub>res-max</sub>	+7°F

#### J. Chilled Water System

##### 1. Chilled Water Pumps, CHWP-1, CHWP-2

- i. The chiller minimum flow is 290 GPM; a single pump is operated to achieve the flow rate.
- ii. Chilled water pump shall operate whenever one or more air handling units has a demand for cooling and the chiller is on.
- iii. Ramp up pump speed until the chilled water flow meter indicates 300 GPM.
- iv. After the chiller has started and has run for 15-minutes, increase pump speed when any chilled water valve is at least 95% open and the air handling unit is still calling for cooling.
- v. Alternate lead/lag pump assignments weekly (adj.) to keep pump operating hour approximately equal.
- vi. If the lead pump fails to start, then start the lag pump and alarm the BMS operator.

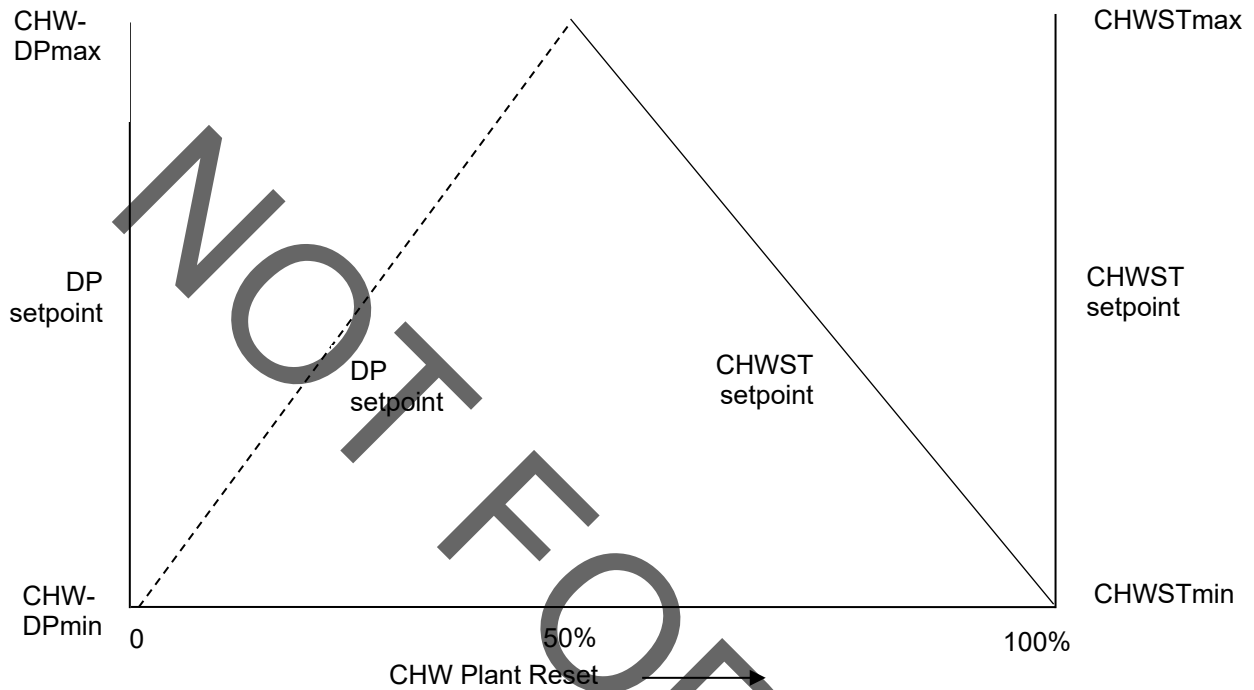
##### 2. Chiller, CH-1

- i. The chiller shall operate based on demand. If there is a call for cooling from one of the air handling unit chilled water control valves, the chiller and lead chilled water pump shall be enabled.
- ii. The chiller's compressors shall modulate based on internal programming from the manufacturer.
- iii. The chiller shall cycle off whenever all chilled water valves are closed and there is no call for cooling.

iv. Alarm the BAS operator of any chiller alarms.

### 3. Chilled Water Plant Reset

- i. Differential Pressure Controlled Loops: Chilled water supply temperature setpoint CHWSTsp and pump differential pressure setpoint CHW-DPsp shall be reset based on the current value of the logic variable called "CHW Plant Reset" as shown below and described subsequently.



- 1) From 0% loop output to 50% loop output, reset DP setpoint from CHW-DPmin to CHW-DPmax. DP minimum and maximum values shall be determined during test and balance based on the following conditions:
  - a) CHW-DPmin shall be the value required to maintain chiller minimum flow with all 3-way valves in full bypass condition.
  - b) CHW-DPmax shall be the value required to provide design CHW flow to all cooling coils.
- 2) From 50% loop output to 100% loop output, reset CHWST setpoint from CHWSTmax to CHWSTmin.
- 3) CHW Plant Reset variable shall be reset using Trim & Respond logic with the following parameters:

Variable	Value
Device	Any CHW Pump Distribution Loop
SP <sub>0</sub>	100%
SP <sub>min</sub>	0%
SP <sub>max</sub>	100%
T <sub>d</sub>	15 minutes
T	5 minutes
I	2
R	Cooling CHWST Reset Requests
SP <sub>trim</sub>	-2%
SP <sub>res</sub>	+3%
SP <sub>res-max</sub>	+7%

- 4) CHWST Plant Reset loop shall be enabled when the plant is enabled and disabled when the plant is disabled.

#### 1.04 BUILDING REPORTS

- A. Provide year-around scheduling incorporating school holidays and vacations as provided by the Owner.
- B. Annunciation of events and occurrences on three levels: routine maintenance, low-level alarm condition; high-level alarm condition.
  1. Maintenance alarms shall annunciate conditions that require routine maintenance, such as dirty filters, or hours of equipment operation reaching elapsed time for scheduled preventive maintenance.
  2. Low-level alarm shall annunciate conditions which reflect inoperability of equipment that would not prevent the HVAC systems from providing service but requires maintenance or repair to re-establish operation such as a failed pump or filter alarm.
  3. High-level alarms shall annunciate conditions which require immediate response in order to insure provision of building HVAC, or that reflect a catastrophic failure of equipment.
  4. Contractor shall submit to the Engineer for review and approval designation of all conditions for annunciation. All equipment shall be monitored for elapsed time between inspection and service; all status of inoperability shall be monitored; all alarm conditions as indicted in this Section shall be monitored by the DDC system. All conditions as indicated herein shall annunciate via overriding screen display; display and output shall be submitted for review and approval.
- C. Trending of system and component operation and completion of trend logs in tabular and graphical format suitable for binding in a weekly, monthly, and yearly report. Reports shall consist of full-page form-fed output with headers, subheadings, dates, times, instrument numbers, etc. Output shall be submitted for review and approval.
- D. Trending shall be set at 15-minute intervals for normal operations. Trending shall be set at 5-minute intervals for the commissioning phase.
  1. Weekly report shall consist of the following:
    - i. Hourly supply air temperature
    - ii. Hourly return air temperature
    - iii. Hourly OSA temperature and CFM
    - iv. Hours of full economizer operation
    - v. Events and occurrences.

2. Monthly report shall consist of the following:
  - i. Recap of events and occurrences.
  - ii. Hours of operation in each piece of equipment.
  - iii. Identification of equipment approaching elapsed time for preventative maintenance.
  - iv. Identification of equipment passed elapsed time for preventative maintenance.
  - v. Hourly supply air temperature
  - vi. Hourly return air temperature
  - vii. Hourly OSA temperature and CFM
  - viii. Hours of full economizer operation
  - ix. Temperature trending data of all IDF, BFD and Elevator equipment rooms.
3. Yearly report shall consist of the following:
  - i. Monthly hours of full economizer operation

**PART 2 - PRODUCTS (NOT APPLICABLE)**

**PART 3 - EXECUTION (NOT APPLICABLE)**

**END OF SECTION**

## SECTION 23 21 13

### HYDRONIC PIPING

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Plastic pipe and fittings.
4. Joining materials.
5. Transition fittings.
6. Dielectric fittings.

- B. Related Sections include the following:

1. Section 230719 "HVAC Piping Insulation" for piping insulation.

##### 1.03 DEFINITIONS

- A. PTFE: Polytetrafluoroethylene.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- B. Product Data: For each type of the following:

1. Piping, tubing and fittings data. Submit data indicating that pipe, tube and fittings are manufactured exclusively in the United States.
2. Fittings.
3. Joining materials.
4. Coating data. Include product information and coating procedures.

- C. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.



- B. Welding (WPS) and Brazing (BPS) Procedure Specifications.
- C. Field quality-control reports.

1.06 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations or coring of foundation wall penetrations.
- C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base.
- F. Coordinate installation of pipe sleeves or coring of existing walls for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section "Penetration Firestopping" for fire and smoke wall and floor assemblies.

**PART 2 - PRODUCTS**

2.01 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
  - 1. Hot-Water Heating Piping: 150 psig at 200 deg F.
  - 2. Chilled-Water Piping: 150 psig at 80 deg F.

2.02 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L, ASTM B 88 Type K.
- B. Wrought-Copper Fittings: ASME B16.22.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - i. Anvil International, Inc.
    - ii. S. P. Fittings; a division of Star Pipe Products.

2.03 STEEL PIPE AND FITTINGS

- A. Piping and fittings shall be manufactured exclusively in the United States.
- B. Steel Pipe, NPS ¾ through NPS 1½: ASTM A53, Type S (seamless) Grade A, Schedule 40, black steel, plain ends.
- C. Steel Pipe, NPS 2 through NPS 10: ASTM A53, Type S (seamless) and Type ERW (welded) Grade A or B, Schedule 40, black steel, plain ends.
- D. Steel Pipe, NPS 12 and larger: ASTM A53, Type S and Type ERW (welded) Grade B, 0.375 inch wall thickness, black steel, plain ends.
- E. Steel Pipe Nipples: ASTM A733 made of ASTM A53, Schedule 40, black steel; seamless.
- F. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- G. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- H. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
  2. End Connections: Butt welding.
  3. Facings: Raised face.
- I. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
  - J. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

## 2.04 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
    - i. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - ii. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel if unexposed, 316 stainless steel if flange is exposed.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

## 2.05 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Capitol Manufacturing Company.
    - ii. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - iii. Wilkins; a Zurn company.
  2. Description:
    - i. Standard: ASSE 1079.
    - ii. Pressure Rating: 125 psig minimum at 180 deg F
    - iii. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Capitol Manufacturing Company.
    - ii. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

iii. Wilkins; a Zurn company.

2. Description:

- i. Standard: ASSE 1079.
- ii. Factory-fabricated, bolted, companion-flange assembly.
- iii. Pressure Rating: 175 psig.
- iv. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. Advance Products & Systems, Inc.
- ii. Calpico, Inc.
- iii. Central Plastics Company
- iv. Pipeline Seal and Insulator, Inc.

2. Description:

- i. Nonconducting materials for field assembly of companion flanges.
- ii. Pressure Rating: 150 psig
- iii. Gasket: Neoprene or phenolic.
- iv. Bolt Sleeves: Phenolic or polyethylene.
- v. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. Elster Perfection
- ii. Grinnell Mechanical Products
- iii. Matco-Norca, Inc.
- iv. Precision Plumbing Products, Inc.
- v. Victaulic Company

2. Description:

- i. Standard: IAPMO PS 66.
- ii. Electroplated steel nipple, complying with ASTM F 1545.
- iii. Pressure Rating: 300 psig at 225 deg F.
- iv. End Connections: Male threaded or grooved.
- v. Lining: Inert and noncorrosive, propylene.

## **PART 3 - EXECUTION**

### **3.01 PIPING APPLICATIONS**

A. Hot-water heating piping, aboveground, NPS 2-1/2 and smaller, shall be the following:

1. Type L drawn-temper copper tubing, with 95-5 soldered wrought-copper fittings.
  2. Insulated per Section 230719 HVAC Piping Insulation.
- B. Chilled-water piping, aboveground exposed areas and mechanical rooms, NPS 2 and smaller shall be the following:
1. Type L drawn-temper copper tubing, with 95-5 soldered wrought-copper fittings or pressure-seal joints.
  2. Insulated per Section 230719 HVAC Piping Insulation.
- C. Chilled-water piping, aboveground exposed areas and mechanical rooms, NPS 2-1/2 and larger, shall be any the following:
1. Black steel pipe, ASTM A53, Type S (seamless) or Type ERW (welded); with standard weight ASTM A234 forged steel fittings for butt-weld connection and flanged joints.
  2. Insulated per Section 230719 HVAC Piping Insulation.
- D. Condensate-Drain Piping: Type L drawn-temper copper tubing, with 95-5 soldered wrought-copper fittings

### 3.02 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings or integrally reinforced forged branch outlet fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to the following:
  1. Section 230523.12 "Ball Valves for HVAC Piping."

- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors.
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

### 3.03 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 and Larger: Use dielectric flange kits.

### 3.04 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 7 feet.
  - 2. NPS 1: Maximum span, 7 feet.
  - 3. NPS 1-1/2: Maximum span, 9 feet.
  - 4. NPS 2: Maximum span, 10 feet.
  - 5. NPS 2-1/2: Maximum span, 11 feet.
  - 6. NPS 3 and Larger: Maximum span, 12 feet.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
  - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.

4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

### 3.05 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Braze Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

### 3.06 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

### 3.07 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  1. Leave joints, including welds, uninsulated and exposed for examination during test.
  2. Inspect finish of exposed, hydronic piping, including outlets, valves, specialties, and devices, after installation is complete. Remove burrs, dirt, and debris. Repair damaged finishes including chips, scratches, and abrasions.
  3. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

4. Flush hydronic piping systems with minimum 5 ft/s velocity clean water; then remove and clean or replace strainer screens. Promptly passivate and chemically treat piping systems after flush per requirements in Section 232513 "Water Treatment for Closed-Loop Hydronic Systems."
5. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.08 CLEANING AND PROTECTION

- A. Remove all packaging, unused fasteners, and other installation materials from the project site.
- B. Provide protection as required to leave the work in undamaged condition at the time of completion.

**END OF SECTION**

## SECTION 23 21 16

### HYDRONIC PIPING SPECIALTIES

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes:
  - 1. Hydronic specialty valves.
  - 2. Air-control devices.
  - 3. Strainers.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product:
  - 1. Include construction details and material descriptions for hydronic piping specialties.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

##### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

##### 1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

##### 1.06 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.



## **PART 2 - PRODUCTS**

### **2.01 HYDRONIC SPECIALTY VALVES**

#### **A. Bronze, Calibrated-Orifice, Balancing Valves:**

1. Manufacturers:
  - i. Bell & Gossett, A Zylem brand.
  - ii. Armstrong Pumps, Inc.
  - iii. TACO Comfort Solutions, Inc.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

### **2.02 AIR-CONTROL DEVICES**

#### **A. Manual Air Vents:**

1. Body: Bronze body ball valve with stainless steel ball, NPS 1/2.
2. CWP Rating: 150 psig.
3. Maximum Operating Temperature: 225 deg F.

### **2.03 STRAINERS**

#### **A. Y-Pattern Strainers up to NPS 1.5:**

1. Manufacturers:
  - i. The Metraflex Company.
  - ii. Keckley.
  - iii. Mueller Steam Specialty.
2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded.
4. Strainer Screen: 40 mesh stainless-steel screen.
5. CWP Rating: 125 psig.

#### **B. Y-Pattern Strainers NPS 2 and Larger:**

1. Manufacturers:
  - i. The Metraflex Company Model LPD.
  - ii. Or Engineer approved equal.
2. Y-strainer shall be of low pressure drop design with the following Cv values:
  - i. 2" Pipe 120

- ii. 2.5" Pipe 160
  - iii. 3" Pipe 236
  - iv. 4" Pipe 460
  - v. 6" Pipe 952
  - vi. 8" Pipe 1,580
  - vii. 10" Pipe 2,424
  - viii. 12" Pipe 3,200
- 3. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection. Strainer shall be suitable for horizontal and vertical mounting.
  - 4. End Connections: Flanged ends.
  - 5. Strainer Screen: Stainless-steel, screen perforations shall be:
    - i. For liquid service for NPS 2 – 3, perforation shall be 0.045"
    - ii. For liquid service for NPS 4 – 12, perforation shall be 0.125"
  - 6. Pressure Taps: Provide with inlet and outlet pressure plugs.
  - 7. CWP Rating: 125 psig.

### **PART 3 - EXECUTION**

#### **3.01 VALVE APPLICATIONS**

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

#### **3.02 HYDRONIC SPECIALTIES INSTALLATION**

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

#### **3.03 TERMINAL EQUIPMENT CONNECTIONS**

- A. Provide flexible pipe connection to and from terminal, VAV or lab boxes.
- B. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- C. Install control valves in accessible locations close to connected equipment.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Section 230519 "Meters and Gages for HVAC Piping."

**END OF SECTION**

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## SECTION 23 21 23

### HYDRONIC PUMPS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes:

- 1. Separately coupled, base-mounted, end-suction centrifugal pumps.

##### 1.03 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements".
- B. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- C. Shop Drawings: For each pump.
  - 1. Show pump layout and connections.
  - 2. Include setting drawings with templates for installing foundation, anchor bolts and other anchorages.
  - 3. Include diagrams for power, signal, and control wiring.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

##### 1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Mechanical Seals: One mechanical seal for each pump.

#### **PART 2 - PRODUCTS**

##### 2.01 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers:
  - 1. Bell & Gossett.
  - 2. Armstrong Pumps, Inc.
  - 3. Paco Pumps.

- B. Description: Factory-assembled and tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
  2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
  3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
  5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed and rigidly mounted to pump casing.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- H. Capacities and Characteristics: Shown in Pump Schedule on Drawings.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine all pumps before installation. Reject pumps that are damaged.
- B. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- D. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Equipment Mounting:
  - 1. Install base-mounted pumps on cast-in-place concrete equipment bases.

### 3.03 ALIGNMENT

- A. Engage a factory-authorized service representative to perform alignment service.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
  - 1. Alignment shall be reverse dial indicator or laser method.
  - 2. Indicated run-out shall not exceed 0.001 inches.
  - 3. Angular and offset misalignment shall be as follows:

	Maximum Angularity	Maximum Offset
1200 rpm	0.0015"	0.001"
1800 rpm	0.0010"	0.001"
3600 rpm	0.0005"	0.001"

- E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### 3.04 CONNECTIONS

- A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check and shutoff valves on discharge side of pumps. A check valve is not required in a single pump configuration.
- F. Install strainer or suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors with vane straighteners on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping.
- I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:
  - i. Verify bearing lubrication.
  - ii. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
  - iii. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

### 3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train College's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals. Refer to Division 01.
3. Schedule training with Owner's Representative.

**END OF SECTION**

## SECTION 23 23 00

### REFRIGERANT PIPING

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Refrigerant pipes and fittings.
  - 2. Refrigerants.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of refrigerant piping.
- B. Shop Drawings:
  - 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
  - 2. Show interface and spatial relationships between piping and equipment.
  - 3. Shop Drawing Scale: 1/4 inch equals 1 foot.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.05 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

##### 1.06 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

#### **PART 2 - PRODUCTS**

##### 2.01 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
  - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
  - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

##### 2.02 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.



- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.

## **PART 3 - EXECUTION**

### **3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A**

- A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

### **3.02 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Liquid lines may be installed level.
- L. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- M. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- N. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- O. Install sleeves for piping penetrations of walls, ceilings, and floors.

### 3.03 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- E. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

### 3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- B. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.05 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Comply with ASME B31.5, Chapter VI.
  - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
    - i. Fill system with nitrogen to the required test pressure.
    - ii. System shall maintain test pressure at the manifold gage throughout duration of test.
    - iii. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - iv. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.06 SYSTEM CHARGING

- A. Charge system according to the manufacturer's installation and operation manual.

3.07 ADJUSTING

- A. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- B. Adjust set-point temperature of air-conditioning controllers to the system design temperature.
- C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Verify that compressor oil level is correct.
  - 2. Open compressor suction and discharge valves.
  - 3. Open refrigerant valves except bypass valves that are used for other purposes.
  - 4. Check open compressor-motor alignment and verify lubrication for motors and bearings.

**END OF SECTION**

## SECTION 23 31 13

### METAL DUCTS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealant and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

###### B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

##### 1.03 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
  1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.

##### 1.04 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  1. "No Exception Taken".
  2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the licensed structural engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - i. Lighting fixtures.
  - ii. Air outlets and inlets.

- iii. Speakers.
  - iv. Sprinklers.
  - v. Access panels.
  - vi. Perimeter moldings.
- B. Field quality-control reports.

## **PART 2 - PRODUCTS**

### **2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS**

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### **2.02 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS**

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Factory- or shop-fabricated spiral lock seam duct:
    - i. No snap lock
    - ii. Factory-fabricated longitudinal seam acceptable for ducts larger than standard factory sizes
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support

intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Fittings:

1. Same material and construction as duct in which installed
2. For ductwork exposed to occupant view, do not use fabricated fittings at taps to terminal units and outlets. Instead use saddle tap cut into continuous spiral duct. Intent is for spiral duct to be continuous for aesthetic reasons. Saddle tap flange width shall be 0.5 inches or less.

F. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.03 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. General Applications (except as noted below): G60 Galvanized Coating.
  2. Plenum Walls and Blank-Offs Where in Contact with Cooling Coil: G90 Galvanized Coating.
  3. Exterior Applications: G90 Galvanized Coating.
  4. Finishes for Surfaces Exposed to View to be Painted: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.04 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - i. CertainTeed Corporation; Insulation Group
    - ii. Johns Manville
    - iii. Knauf Insulation

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - i. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  3. Butt transverse joints without gaps, and coat joint with adhesive.
  4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
  5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
  7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    - i. Fan discharges.
    - ii. Intervals of lined duct preceding unlined duct.
    - iii. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

## 2.05 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.



3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  8. Service: Indoor or outdoor.
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
  2. Type: S.
  3. Grade: NS.
  4. Class: 25.
  5. Use: O.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## 2.06 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.07 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Hilti Corp.
  2. TOLCO; a brand of NIBCO Inc.
  3. Unistrut Corporation; Tyco International, Ltd.

- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by the Office of Statewide Health Planning and Development for the State of California.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Reinforcing steel angle or channel unistrut clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

### **PART 3 - EXECUTION**

#### **3.01 DUCT INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers as required by NFPA 90A. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

### 3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.03 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 1-Inch wg and Lower: Seal Class B.
  - 3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 1-Inch wg: Seal Class A.
  - 4. Unconditioned Space, Exhaust Ducts: Seal Class B.
  - 5. Unconditioned Space, Return-Air Ducts: Seal Class A.
  - 6. Conditioned Space, Supply-Air Ducts in Pressure Classes 1-Inch wg and Lower: Seal Class B.
  - 7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 1-Inch wg: Seal Class A.
  - 8. Conditioned Space, Exhaust Ducts: Seal Class A.
  - 9. Conditioned Space, Return-Air Ducts: Seal Class A.

### 3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum

Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.05 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with [SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems"].
  - 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
  - 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

### 3.06 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.07 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

### 3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
  1. Ducts with a Pressure Class Higher Than 2-Inch wg: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days advance notice for testing.

- C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

- D. Contractor shall develop and implement an IAQ Management Plan for the construction and preoccupancy phases of the building as follows:

1. During construction meet or exceed the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, and Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).
2. Protect stored materials on-site and installed absorptive materials from moisture damage.
3. If permanently installed air handlers are used during construction, then filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-2012 (with errata, but without addenda). Replace air filtration media immediately prior to occupancy.

- E. Duct system will be considered defective if it does not pass tests and inspections.

- F. Prepare test and inspection reports.

### 3.09 DUCT CLEANING

- A. Clean [**existing**] air handling unit system(s) before testing, adjusting, and balancing.

- B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined

duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
2. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
3. Coils and related components.
4. Return-air ducts, dampers, actuators, and turning vanes.
5. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
  - i. Pressure Class: Positive 1-inch wg.
  - ii. Minimum SMACNA Seal Class: B.
  - iii. SMACNA Leakage Class for Rectangular: 8.
  - iv. SMACNA Leakage Class for Round and Flat Oval: 4.
2. Ducts Connected to Variable-Air-Volume Air-Handling Units:
  - i. Pressure Class: Positive 3-inch wg.
  - ii. Minimum SMACNA Seal Class: A.
  - iii. SMACNA Leakage Class for Rectangular: 4.
  - iv. SMACNA Leakage Class for Round and Flat Oval: 2.
3. Ducts Connected to Equipment Not Listed Above:
  - i. Pressure Class: Positive 2-inch wg.
  - ii. Minimum SMACNA Seal Class: A.
  - iii. SMACNA Leakage Class for Rectangular: 4.
  - iv. SMACNA Leakage Class for Round and Flat Oval: 2.

C. Return Ducts:

1. Ducts Connected to Air-Handling Units:
  - i. Pressure Class: Positive or negative 3-inch wg.
  - ii. Minimum SMACNA Seal Class: A.
  - iii. SMACNA Leakage Class for Rectangular: 4.
  - iv. SMACNA Leakage Class for Round and Flat Oval: 2.
2. Ducts Connected to Equipment Not Listed Above:
  - i. Pressure Class: Positive or negative 1-inch wg.
  - ii. Minimum SMACNA Seal Class: A.
  - iii. SMACNA Leakage Class for Rectangular: 4.
  - iv. SMACNA Leakage Class for Round and Flat Oval: 2.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - i. Pressure Class: Negative 2-inch wg.
  - ii. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
  - iii. SMACNA Leakage Class for Rectangular: 4.
  - iv. SMACNA Leakage Class for Round and Flat Oval: 2.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Air-Handling Units:
  - i. Pressure Class: Positive or negative 2-inch wg.

- ii. Minimum SMACNA Seal Class: A.
- iii. SMACNA Leakage Class for Rectangular: 4.
- iv. SMACNA Leakage Class for Round and Flat Oval: 2.

F. Intermediate Reinforcement:

- 1. Galvanized-Steel Ducts: Galvanized steel.

G. Liner:

- 1. Supply Air Ducts: **[Fibrous glass, Type I] [1 inch]** thick.
- 2. Return Air Ducts: **[Fibrous glass, Type I] [1 inch]** thick.
- 3. Transfer Ducts: **[Fibrous glass, Type I] [1 inch]** thick.

H. Elbow Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - i. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - ii. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and single-thickness turning vanes.
  - iii. Mitered Type RE 2 with single-thickness vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
  - i. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Radius-to Diameter Ratio: 1.5.
  - ii. Round Elbows, 10 Inches and Smaller in Diameter: Stamped or pleated.
  - iii. Round Elbows, 12 Inches and Larger in Diameter: Welded.

I. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
  - i. Rectangular Main to Rectangular Branch: 45-degree entry.
  - ii. Rectangular Main to Round Branch: Spin in.
- 2. Taps shall be the more stringent of what is shown on the mechanical drawings and the criteria listed below. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - i. Velocity 900 fpm or Lower: 90-degree tap.
  - ii. Velocity 901 to 1500 fpm: Conical tap.
  - iii. Velocity 1501 fpm or Higher: 45-degree lateral.

**END OF SECTION**



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## SECTION 23 33 00

### AIR DUCT ACCESSORIES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Manual volume dampers.
2. Combination fire and smoke dampers.
3. Flange connectors.
4. Duct silencers.
5. Turning vanes.
6. Remote damper operators.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Flexible ducts
10. Duct accessory hardware.

###### B. Related Requirements:

1. Section 284621.11 "Addressable Fire-Alarm Systems" for duct-mounted fire and smoke detectors.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

###### B. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

###### C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
  - i. Special fittings.

- ii. Manual volume damper installations.
- iii. Combination fire- and smoke-damper, including sleeves; and duct-mounted access doors and remote damper operators.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

**PART 2 - PRODUCTS**

2.01 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts and No. 4 finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 MANUAL VOLUME DAMPERS

- A. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- B. Fabricate splitter dampers of material same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.

- C. Fabricate splitter dampers of single thickness sheet metal to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/4 inch diameter rod in self aligning, universal joint action flanged bushing with set screw.
- D. Fabricate single blade dampers for duct sizes to 12 x 48 inch.
- E. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- F. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- G. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.
- H. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

## 2.04 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
    - 1. Greenheck Type FSD-212 or equal for 1500 feet per minute and below.
    - 2. Greenheck Type FSD-311 or equal for above 1500 feet per minute.
    - 3. Or equal by Ruskin or Pottoff.
  - B. Combination Smoke/Fire Dampers shall be furnished and installed at all locations shown on the plans and/or as described on the drawing details and suitable for closure against duct operating pressure up to Design Static Pressure class.
  - C. Damper shall meet the requirements of NFPA 90A, 92A, and 92B and further shall be tested, rated and labeled in accordance with the latest edition on UL Standard 555 and 555S. Dampers shall be UL rated per the CBC 717.3.1.
  - D. Damper shall be of low leakage design qualified to UL 555S Leakage Class II.
1. Damper actuator combination shall have a UL 555S elevated temperature rating of 350 degrees Fahrenheit minimum and shall be operational and dynamic rated to operate at maximum design airflow rate at its installed location.
  2. Damper shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall be electric type for 120-volt operation.
  3. Damper blades shall be 16-gauge galvanized steel 3 Vee type with three longitudinal grooves for reinforcement. Damper frame shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearing shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Blade seals shall be silicone rubber designed to inflate and provide a tighter seal against leakage as pressure on either side of the damper increases. Jamb seals shall be stainless steel compression type with silicone rubber backing. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper.
  4. Damper must be rated for mounting vertically (with blades running horizontally) or horizontally and be UL 555S rated for leakage and airflow in either direction through the damper.
  5. Damper shall be supplied with a 165-degree Fahrenheit fusible link. Provide access doors at either side of the combination smoke/fire damper for viewing of the fusible links.

6. The specified combination smoke/fire damper shall meet the requirements for fire dampers, smoke dampers and combination fire smoke dampers established by:
  7. National Fire Protection Association NFPA Standard 90A, 92A, 92B and 101
  8. Underwriters Laboratories Standard 555 Listing #R-13317
  9. Underwriters Laboratories Standard 555S Listing #R-13447
  10. California State Fire Marshall CSFM Fire Damper Listing #3225-0981:103
  11. California State Fire Marshall CSFM Leakage Smoke Damper Listing #3230-0981:104
12. Smoke Detector will be provided by the electrical contractor to be compatible with the fire alarm system. Mechanical contractor shall install all duct-mounted smoke detectors. Electrical contractor shall connect smoke detector to smoke dampers and fire alarm panel. After installation is complete, electrical contractor shall test and verify that smoke detectors are active and functional.

#### 2.05 FLANGE CONNECTORS

- A. Manufacturer shall be Ductmate, CL WARD, or equal.
- B. Description: [Add-on], factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

#### 2.06 DUCT SILENCERS

- A. Manufacturer shall be Vibro-Acoustics, IMI Acoustics Corp, or equal.
- B. General Requirements:
  1. Factory fabricated.
  2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
  3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Shape:
  1. Rectangular straight with splitters or baffles.
  2. Round straight with center bodies or pods.
  3. Rectangular elbow with splitters or baffles.
  4. Round elbow with center bodies or pods.
  5. Rectangular transitional with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.040 inch thick.
- E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel.
  1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
  2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
  3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.05 inch thick.
  4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

- F. Inner Casing and Baffles: ASTM A 653/A 653M, G60 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch- diameter perforations.
- G. Special Construction:
1. High transmission loss to achieve STC 45.
- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- I. Principal Sound-Absorbing Mechanism:
1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
  2. **[Dissipative]** type with fill material.
    - i. Fill Material: [Inert and vermin-proof fibrous material, packed under not less than 5 percent compression].
    - ii. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
  3. Lining: **[None]**.
- J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. Joints: [Lock formed and sealed].
  2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
  3. Reinforcement: Cross or trapeze angles for rigid suspension.
- K. Accessories:
1. Factory-installed end caps to prevent contamination during shipping.
- L. Source Quality Control: Test according to ASTM E 477.
1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
  2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.
- M. Capacities and Characteristics:
1. Configuration: **[Straight]**.
  2. Shape: [Rectangular].
  3. Attenuation Mechanism: **[Acoustical glass fiber]**.
  4. Maximum Pressure Drop: Refer to schedule.
  5. Casing:
    - i. Attenuation: **[Standard]**.
    - ii. Outer Material: **[Galvanized steel]**.
    - iii. Inner Material: **[Galvanized steel]**.
  6. Length: Refer to schedule.
  7. Dimensions: Refer to schedule.
  8. Face Velocity: Refer to schedule.
  9. Dynamic Insertion Loss: Refer to schedule.

10. Generated Noise: Refer to schedule.

11. Accessories:

2.07 TURNING VANES

- A. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- B. Vane Construction: Single wall for ducts up to [48 inches] <Insert dimension> wide and double wall for larger dimensions.

2.08 REMOTE DAMPER OPERATORS

- A. Manufacturer shall be Young Regulator, Pottorff or equal.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.
- E. Wall-Box Mounting: Recessed.
- F. Wall-Box Cover Plate Material: Stainless Steel.

2.09 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers shall be Ventfrabrics, Ductmate, Pottorf Company or equal.
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards and as indicated.
- C. Review locations prior to fabrication.
- D. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- E. Access doors smaller than 12 inches square may be secured with sash locks.
- F. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- G. Access doors with sheet metal screw fasteners are not acceptable.

2.10 FLEXIBLE CONNECTORS

- A. Manufacturer: Ventfrabrics, Duro Dyne or equal.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd.
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.11 FLEXIBLE DUCTS

- A. Manufacturers:
  - 1. Casco,
  - 2. Thermaflex,

3. Or submitted equal approved by the Engineer of Record.
- B. Flexible Ductwork up to 22" ID:
1. UL 181, Class I Air Duct.
  2. Minimum positive static pressure class: 2 inches w.c.
  3. Minimum negative pressure class: 1/2 inch w.c.
  4. Insulated to a minimum of R-4.2.
  5. Product basis of design: Casco Silent-Flex II SF-181M or submitted equal approved by the Engineer of Record.

## 2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## **PART 3 - EXECUTION**

### 3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install **[backdraft] [control]** dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  1. Install steel volume dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Connect ducts to duct silencers **[rigidly]**.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  1. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.



2. Upstream or downstream from duct silencers.
  3. Control devices requiring inspection.
  4. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches
  2. Two-Hand Access: 12 by 6 inches
  3. Head and Hand Access: 18 by 10 inches
  4. Head and Shoulders Access: 21 by 14 inches
  5. Body Access: 25 by 14 inches
  6. Body plus Ladder Access: 25 by 17 inches
- L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. Where indicated on Drawings, connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands.
- P. Install duct test holes where required for testing and balancing purposes.

### 3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
  2. Inspect locations of access doors and verify that purpose of access door can be performed.
  3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  4. Inspect turning vanes for proper and secure installation.
  5. Operate remote damper operators to verify full range of movement of operator and damper.

**END OF SECTION**

## SECTION 23 34 23

### HVAC FANS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:

- 1. Centrifugal roof ventilators.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

- 1. "No Exception Taken".
- 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

- B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

- 1. Certified fan performance curves with system operating conditions indicated.
- 2. Certified fan sound-power ratings.
- 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
- 4. Material thickness and finishes, including color charts.
- 5. Dampers, including housings, linkages, and operators.
- 6. Roof curbs.
- 7. Fan speed controllers.

- C. Shop Drawings:

- 1. Include plans, elevations, sections, and attachment details.
- 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 3. Include diagrams for power, signal, and control wiring.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC fans to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: HVAC fans shall comply with UL 705. HVAC fans for use for restaurant kitchen exhaust shall also comply with UL 762.

1.08 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- D. Provide access around equipment as specified on plans and/or according to manufacturer's requirements.

1.09 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents
- B. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturer's option when returned to Manufacturer, transportation prepaid.

**PART 2 - PRODUCTS**

2.01 PERFORMANCE REQUIREMENTS

- A. Unusual Service Conditions

1. Base fan-performance ratings on the following:

- i. Ambient Temperature: 70 deg F.
- ii. Altitude: 0 feet above sea level.

- B. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: [1.0].
3. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>.

## 2.02 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

### A. Manufacturers:

1. Loren Cook Company.
2. Greenheck Fan Company.
3. PennBarry
4. Twin City Fans

B. Housing: Downblast; removable [**spun-aluminum dome top and outlet baffle**]; square, one-piece aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

### D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [5] hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [5] hp.
6. Fan and motor isolated from exhaust airstream.

### E. Accessories:

1. Electronically Commutated Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent based on external analog signal.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**] fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, **1/2-inch** mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

## 2.03 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

### A. Manufacturers:

1. Greenheck Fan Company.
2. Loren Cook Company.
3. PennBarry
4. Twin City Fans

B. Configuration: Centrifugal [**roof upblast**] ventilator.

C. Housing: Removable [**spun-aluminum dome top and outlet baffle**]; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Accessories:

1. Electronically Commutated Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent based on external analog signal.
  2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [inside] fan housing, factory wired through an internal aluminum conduit.
  3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: [Self-flashing without a cant strip, with mounting flange]
  2. Overall Height: [12 inches].

2.04 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.05 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

## **PART 3 - EXECUTION**

3.01 INSTALLATION

- A. Install HVAC fans level and plumb.
- B. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

- D. Install units with clearances for service and maintenance of fans, motors and all other components that may need access
- E. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.02 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to HVAC fans to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5. Adjust belt tension.
  - 6. Adjust damper linkages for proper damper operation.
  - 7. Verify lubrication for bearings and other moving parts.
  - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  - 10. Shut unit down and reconnect automatic temperature-control operators.
  - 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

### 3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

**END OF SECTION**

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## SECTION 23 36 00

### AIR TERMINAL UNITS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Single-duct air terminal units.
  - 2. Casing liner.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of air terminal unit.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Shop Drawings: For air terminal units.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Ceiling suspension assembly members.
  - 2. Size and location of initial access modules for acoustic tile.
  - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- B. Field quality-control reports. See Execution: "Field Quality Control."

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.



1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - i. Instructions for resetting minimum and maximum air volumes.
  - ii. Instructions for adjusting software set points.
  - iii. Instructions for configuring all thermostat settings

## **PART 2 - PRODUCTS**

### **2.01 SYSTEM DESCRIPTION**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### **2.02 SINGLE-DUCT AIR TERMINAL UNITS**

- A. Manufacturers
  1. Titus
  2. Price
  3. Krueger
  4. Or approved Equal
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: Minimum 22-gauge galvanized steel, 304 stainless steel, or 0.04-inch thick aluminum.
  1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
  2. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
  1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 6 inches w.g. inlet static pressure.
  2. Damper Position: Normally closed. Spring return not required.
- E. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- F. Velocity Sensor: Multipoint array with velocity sensor in air inlet.
- G. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

### **2.03 CASING LINER**

- A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  1. Minimum Thickness: 1 inch.
    - i. Maximum Thermal Conductivity:
      - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

## **PART 3 - EXECUTION**

### **3.01 HANGER AND SUPPORT INSTALLATION**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### **3.02 SEISMIC-RESTRAINT-DEVICE INSTALLATION**

- A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7. Comply with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on air terminal units that are suspended with vibration isolators.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- F. Drilling for and Setting Anchors:
  1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

### 3.03 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Measures shall be taken to protect all unit components from construction dust debris:
  1. Unit interior
  2. Heating coil
  3. Heating valve
  4. Dampers
  5. Actuators, damper and heating valve.
  6. Controller
  7. Thermostats

### 3.04 CONNECTIONS

- A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

### 3.05 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### 3.06 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Air terminal unit will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.07 STARTUP SERVICE

- A. Perform startup service and coordinate with Commissioning Agent. Startup reports should be provided to the Commissioning Agent.
1. Complete installation and startup checks according to manufacturer's written instructions.
  2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
  3. Verify that controls and control enclosure are accessible.
  4. Verify that control connections are complete.
  5. Verify that nameplate and identification tag are visible.
  6. Verify that controls respond to inputs as specified.

### 3.08 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

**END OF SECTION**

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## SECTION 23 37 13

### DIFFUSERS, REGISTERS, AND GRILLES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Round ceiling diffusers.
2. Architectural plaque diffusers.
3. Perforated grilles.
4. Linear slot diffusers.
5. Fixed face grilles.

###### B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:

1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

###### B. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
2. Duct access panels.

###### B. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.01 ROUND CEILING DIFFUSERS

- A. Manufacturers:
  - 1. Titus **[TMRA]**.
  - 2. Krueger.
  - 3. Price Industries.
- B. Devices shall be specifically designed for variable-air-volume flows.
- C. Material: **[Steel]**.
- D. Finish: Baked enamel, white
- E. Face Style: **[Four]** cone.
- F. Mounting: Duct connection.
- G. Pattern: [Two-position horizontal].

### 2.02 ARCHITECTURAL PLAQUE DIFFUSERS

- A. Manufacturers:
  - 1. Titus OMNI.
  - 2. Krueger.
  - 3. Price Industries.
- B. Devices shall be specifically designed for variable-air-volume flows.
- C. Material: **[Steel]**.
- D. Finish: Baked enamel, white
- E. Face Style: Refer to Drawings.
- F. Mounting: **[T-bar]**.
- G. Pattern: **[Fixed]**.

### 2.03 PERFORATED GRILLES

- A. Manufacturers:
  - 1. Titus **[PAR]**.
  - 2. Krueger.
  - 3. Price Industries.
- B. Devices shall be specifically designed for variable-air-volume flows.
- C. Material: Steel backpan and pattern controllers, with **[steel]** face.
- D. Finish: Baked enamel, white.
- E. Duct Inlet: Refer to Drawings.
- F. Face Style: Refer to Drawings.
- G. Mounting: **[T-bar]**.

### 2.04 LINEAR SLOT DIFFUSERS

- A. Manufacturers:
  - 1. Titus [FL Series].

2. Krueger.
  3. Price Industries.
- B. Devices shall be specifically designed for variable-air-volume flows.
- C. Material - Shell: **[Steel]**, **[noninsulated]**.
- D. Material - Pattern Controller and Tees: Aluminum.
- E. Finish - Face and Shell: Baked enamel, white.
- F. Finish - Pattern Controller: Baked enamel, black.
- G. Finish - Tees: [Baked enamel, white].
- H. Accessories: Refer to Schedule on Drawings.
- 2.05 GRILLES
- A. Manufacturers:
1. Titus.
  2. Krueger.
  3. Price Industries.
- B. Fixed Face Grille <**RG-2, EG-1**>:
1. Material: **[Steel]**.
  2. Finish: [Baked enamel, white].
  3. Face Blade Arrangement: **[Horizontal]**; spaced **[3/4 inch]**.
  4. Core Construction: **[Integral]**.
  5. Frame: **[1-1/4 inches]** wide.
  6. Mounting: [Countersunk screw].
- 2.06 ACCESSORIES
- A. Flexible Duct Support
1. Manufacturers: Titus FlexRight (no known equal)
    - i. Radius forming brace to support 4-inch through 16-inch diameter flexible air ducts.
    - ii. Provide nylon cable ties to secure flex duct to FlexRight brace.
- 2.07 SOURCE QUALITY CONTROL
- A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install diffusers level and plumb.



- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Install Titus FlexRight brace at all flexible duct-to-diffuser connections.

3.03 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION**

## SECTION 23 52 16

### CONDENSING BOILERS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes packaged, factory-fabricated and assembled, gas-fired, stainless-steel condensing fire-tube boilers, trim, and accessories for generating hot water.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit this specification section showing compliance with each respective paragraph and specified items and features in this section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- C. Shop Drawings: For boilers, boiler trim, and accessories.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.

##### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

##### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: The manufacturer must have been regularly engaged in the manufacture of condensing hydronic boilers for not less than ten (10) years. The manufacturer must be headquartered in North America and manufacture pressure vessels in an ASME-certified facility wholly owned by the manufacturer.
- B. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. AHRI Performance Compliance: Rate boilers in accordance with applicable federal testing methods and is capable of achieving the energy efficiency and performance ratings within prescribed tolerances.

- D. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- E. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- F. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- G. ANSI Z21.13 Compliance: Boilers shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada.
- H. NOx Emission Standards: Boilers shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rules 1146, 1146.1, or 1146.2.

#### 1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Fire-Tube Condensing Boilers:
    - i. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal shock, mechanical defects or workmanship.
    - ii. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.
    - iii. Burner head shall be warranted against failure for five (5) years from shipment.
    - iv. All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months from shipment.

### **PART 2 - PRODUCTS**

#### 2.01 FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers:
  - 1. Raypak
  - 2. Cleaver Brooks
  - 3. Lochinvar
- B. Description:
  - 1. Factory-fabricated, assembled, and tested, forced-draft fire-tube condensing boiler with a sealed pressure tight heat exchanger, built on a steel base.
  - 2. Boiler shall be medium to high-mass, with insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return, and condensate drain connections, and controls.
  - 3. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a minimum working pressure of 100 PSIG.
- C. Heat Exchanger:
  - 1. Stainless-steel tubes and tube sheets and corrosion-resistant combustion chamber.
  - 2. Single-pass, counter-flow arrangement.
- D. Pressure Vessel:
  - 1. Stainless steel with welded heads and tube connections.
  - 2. Water volume shall be no less than 50 gallons per 1,000 MBH input.

- E. Burner: Natural gas, forced draft drawing from gas premixing valve.
- F. Blower: Variable speed centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
  - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    - i. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- G. Gas Train:
  - 1. The gas train shall meet the requirements of CSA/UL and ASME CSD-1 and shall include:
    - i. Minimum 10:1 burner modulation.
    - ii. Low and high gas pressure Interlock, manual reset.
    - iii. Upstream and downstream manual test cocks.
    - iv. Ball type manual shutoff valve upstream of the main gas valve.
    - v. Unibody double safety gas valve assembly.
    - vi. Gas pressure regulator.
    - vii. Union connection to permit burner servicing.
- H. Ignition: Direct spark or hot surface ignition with 100 percent main-valve shutoff with electronic flame supervision.
- I. Casing:
  - 1. Control Compartment Enclosures: NEMA 250, Type 1A.
  - 2. Finish: Baked-enamel or Powder-coated protective finish.
  - 3. Insulation: Minimum 2-inch thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
  - 4. Combustion-Air Connections: Inlet and vent duct collars.
- J. Capacities and Characteristics: See schedules on plans.

## 2.02 TRIM

- A. Include devices sized to comply with ANSI Z21.13.
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and temperature gage. Gages shall have operating pressure and temperature ranges, so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Automatic.
- E. Drain Valve: Minimum NPS 3/4-inch.
- F. Provide condensate neutralization kit.
- G. Integral Circulator:
  - 1. For Fire-Tube Boiler:
    - i. Not required.
    - ii. The boiler shall be designed for primary variable flow.

## 2.03 CONTROLS

- A. Refer to Section 230900 "Direct Digital Control (DDC) System for HVAC" and Section 230993 "Sequence of Operations for HVAC DDC."
  - 1. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.
    - i. Communication shall be BACnet.

## 2.04 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
  - 1. House in NEMA 250, Type 3R enclosure.
  - 2. Wiring shall be numbered, and color coded to match wiring diagram.
  - 3. Install factory wiring outside of an enclosure in a metal raceway.
  - 4. Field power interface shall be to a non-fused disconnect switch.

# **PART 3 - EXECUTION**

## 3.01 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
  - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.02 BOILER INSTALLATION

- A. Equipment Mounting:
  - 1. Install boilers on cast-in-place concrete equipment pad(s) with factory mounting bases.
  - 2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

## 3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Boiler Venting:
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect full size to boiler connections. Comply with requirements in Section 235123 "Gas Vents."
- I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - i. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    - ii. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Boiler will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

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## SECTION 23 81 26

### SPLIT-SYSTEM AIR-CONDITIONERS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

##### 1.03 ACTION SUBMITTALS

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements". The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements. Next to each specification item, indicate the following:
  - 1. "No Exception Taken".
  - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- B. Warranty
- C. Start-up reports

##### 1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."



1.07 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

- i. For Compressor: Five year(s) from date of Substantial Completion.
- ii. For Parts: One year(s) from date of Substantial Completion.
- iii. For Labor: One year(s) from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Samsung
2. Carrier
3. Daikin
4. Mitsubishi

2.02 INDOOR UNITS

- A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:
  - i. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - ii. ECM or Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - iii. Enclosure Type: Totally enclosed, fan cooled.
  - iv. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  - v. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.03 OUTDOOR UNITS

- A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - i. Compressor Type: Scroll.
  - ii. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - iii. Refrigerant Charge: R-410A
  - iv. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

#### 2.04 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Type ACR, Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- D. Drain Hose: For condensate.

### **PART 3 - EXECUTION**

#### 3.01 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure as detailed on the drawings.
- C. Install roof-mounted, compressor-condenser components on equipment supports as detailed on the drawings.

#### 3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

#### 3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.04 STARTUP SERVICE Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION**

## SECTION 26 00 00

### GENERAL ELECTRICAL REQUIREMENTS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SCOPE

- A. Basic electrical requirements specifically applicable to Division 26 Sections.
- B. Work includes but is not necessarily limited to the following:
  - 1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to provide complete and operational electrical systems including:
    - i. All temporary construction power including test power, temporary heat and lighting;
    - ii. Incidental items not indicated on the drawings nor mentioned in the Specifications that belong to the work described, or are required to provide complete and operable systems, as though called out here in every detail;
    - iii. Cleaning, cutting, patching, repairing and painting;
    - iv. Testing and commissioning;
    - v. The Contractor shall coordinate this Section with all other Sections of the Specification.

##### 1.03 DRAWINGS AND SPECIFICATIONS

- A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a workmanlike manner.
- B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.
- C. In the event of a conflict or inconsistency between items indicated on the plans and/or specifications or with code requirements, the note, specification or code which prescribes and establishes the more complete job or the higher standard prevail.
- D. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the Owner has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the Owner's Representative.
- E. For purposes of clearness and legibility, the electrical drawings are essentially diagrammatic. The size and location of equipment is shown to scale where possible. The contractor shall verify all conditions, data information as indicated on the drawings and in the specification sections where electrical work interfaces with other trades.
- F. Contract Documents are intended to show the scope and general arrangement of the Work under this Contract. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the

indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.

- G. The contractor shall maintain as built drawings to reflect all changes made during construction and any deviations from the electrical drawings. This includes deviations from circuit numbers and any addition, deletion or relocation of fixtures/outlets shown on working drawings.

#### 1.04 UTILITIES

- A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given, and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

#### 1.05 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS

- A. Meet requirements of all state codes having jurisdiction.
- B. State of California Code of Regulations:
1. Title 8, Chapter 4. Division of Industrial Safety, Subchapter 5. Electrical Safety Orders (Cal/OSHA):
    - i. Low-Voltage Electrical Safety Orders (Sections 2299 - 2599)
    - ii. High-Voltage Electrical Safety Orders (Sections 2700 - 2989)
  2. Title 19, State Fire Marshal Regulations
  3. Current California Building Code (CBC), Title 24, Part 2
  4. Current California Electrical Code, Title 24, Part 3
  5. Current California Mechanical Code, Title 24, Part 4
  6. Current California Plumbing Code, Title 24, Part 5
  7. Current California Energy Code, Title 24, Part 6
  8. Current California Fire Code, Title 24, Part 9
  9. Current California Standards Code, Title 24, Part 12
- C. Additional Referenced Standards:
1. ANSI American National Standards Institute
  2. IEEE Institute of Electrical and Electronic Engineers
  3. NEMA National Electrical Manufacturer's Association
  4. NFPA National Fire Protection Association Standards
  5. UL Underwriters Laboratories
- D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Nothing in these drawings and specifications shall be construed to permit work not conforming to governing codes or regulations. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the Owner's Representative.
- E. Obtain permits, and request inspections from authority having jurisdiction.

#### 1.06 PROJECT AND SITE CONDITIONS

- A. The arrangement of and connection to equipment shown on the Drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific

manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.

- B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.
- C. Examine site related work and surfaces before starting work of any Section.
- D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.
- E. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the Owner's Representative before proceeding.

1.07 COOPERATION WITH WORK UNDER OTHER DIVISIONS

- A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
- B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.
- C. Work with other trades in determining exact location of outlets, conduits, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.
- D. Make such progress in the Work to not delay work of other trades.

1.08 DISCREPANCIES

- A. The contractor shall check all drawings furnished to him immediately upon their receipt and shall promptly notify the owner of any discrepancies. Figures marked on drawings shall in general be followed in preference to scale measurements. Large scale drawings in general govern small scale drawings. The contractor shall compare all drawings and verify the figures before laying out the work and will be responsible for any errors which might have been avoided thereby. Where no figures or notations are given, the plans shall be followed.
- B. Omissions from the Drawings or Specifications or the erroneous description of details of work which are manifestly necessary to carry out the intent of the Drawings and Specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or erroneously described details of the work but they shall be performed as if fully and correctly set forth and described in the drawings and specifications.
- C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without Owner Representative's decision. Beginning work of any Section constitutes acceptance of conditions.

1.09 CHANGES

- A. The Contractor shall be responsible to make and obtain approval from the Owner's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

1.10 SUBMITTALS

- A. Refer to Division 01 for additional requirements.

- B. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
- C. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
- D. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- E. Note that prior to acceptance of submittals for review, a submittal schedule shall be submitted to the Owner's Representative.
- F. Submit all Division 26 shop drawings and product data grouped and referenced by the specification technical section number in one complete submittal package.
- G. Shop Drawings:
  - 1. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
  - 2. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
  - 3. If equipment is rejected, revise drawings to show acceptable equipment and resubmit.
  - 4. Whenever more than one (1) manufacturer's product is specified, the first named product is the basis of design used in the Drawings and the use of alternate-named manufacturer's products or substitutes may require modifications to the design.
  - 5. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner's Representative bearing the Owner's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the Owner's Representative without additional compensation.
  - 6. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
  - 7. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or UL, submit proof of such conformance to the Owner Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Owner Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.
  - 8. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
  - 9. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet

requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

- H. The Contractor shall submit all passcodes and passwords for any hardware and software required for the operations and troubleshooting in all systems and components no less than fourteen (14) calendar days prior to Final Completion.

#### 1.11 PROJECT AS-BUILT DOCUMENTS

- A. Project As-built drawings will strictly adhere to Division 01 Section 01 78 40. In addition, the following items will be enforced:
  - 1. All changes, deviations and information recorded on the "Project As-Built Documents" during Construction shall be redrafted onto the latest version of AutoCAD or Revit, where applicable.
  - 2. Project As-Built Documents that are submitted with "RFI #" written on the drawings will not be considered as As-Built or Record Drawings

#### 1.12 RECORD DOCUMENTATION

- A. Provide record documentation per Division 01 and district standards. Record information shall include the following:
  - 1. CAD and/or BIM modeling of the final as-built conditions. Format shall be consistent with respect architectural and MEP as-builts. File format AutoCAD 2013 or later, and REVIT 2021 or later.
  - 2. Updates to the district/campus fire life safety operating interface. Allow for graphical programming, commissioning, and training to campus security.

#### 1.13 PRODUCT ALTERNATIVES OR SUBSTITUTIONS

- A. Refer to General Conditions and Division 01 for additional requirements.

#### 1.14 OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

#### 1.15 MANUFACTURER'S RECOMMENDATIONS

- A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

#### 1.16 DELIVERY AND STORAGE

- A. Refer to Division 01 for additional requirements.
- B. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

#### 1.17 GUARANTEE

- A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance



against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.

- B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner for their service agency as directed.

## **PART 2 - PRODUCTS**

### **2.01 COMPETITIVE PRODUCTS**

- A. Unless otherwise noted, any reference in the Specification to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may at his option propose substitutions for such material in accordance with the substitution procedure outlined in the Contract Documents.
- B. Equipment specified in the following SECTIONS shall all be provided by the same manufacturer.
  - 1. 261200 Medium-Voltage Transformers
  - 2. 262300 Low-Voltage Switchgear

### **2.02 MATERIALS**

- A. Provide all new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide materials and equipment approved by UL authority having jurisdiction approved testing agency, wherever standards have been established by that agency.
- B. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of units or equipment need not be products of the same manufacturer.
- C. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.
- D. Provide materials and equipment with manufacturers' standard finish system, except where otherwise specified. Provide manufacturers' standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with ANSI Number 61, light gray color.
- E. Environmental and Seismic Conditions: Material and Equipment shall be designed to insure satisfactory operation and operational life in the environmental and seismic conditions which will prevail where they are being installed. Electrical equipment and enclosures shall be designed, constructed and certified to withstand external loading conditions as prescribed by the California Building Code for the locations of the equipment. Supplied equipment shall either be shake table tested and certified or comprehensive seismic calculations shall be provided. All seismic calculations and structural drawings shall bear the seal of a Structural Professional Engineer currently licensed in the State of California. Earthquake design shall be based on the equivalent lateral force analysis procedure (ASCE 7-05 Section 12.8) with the following factors:
  - 1. Location: 33.971582 LAT, -117.380088 LONG  
Site Class E  
 $S_s = 1.5\text{ g}$ ,  $S_1 = 0.600\text{ g}$ ,  
 $S_{MS} = 1.8\text{ g}$ ,  $S_{M1} = \sim\text{ g}$ ,  
 $S_{DS} = 1.2\text{ g}$ ,  $S_{D1} = \sim\text{ g}$

2. R = 2 (Enclosure Attachment)  
R = 1.5 (Transformer Attachment)
3. CS = 0.51
4. SDC = D
5. V = 52 k (Enclosure and Electrical Equipment)

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the Owner's Representative.

### **3.02 WORK RESPONSIBILITIES**

- A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.
- B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.
- C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the conduit runs, etc. and work directly connected to same is installed and no extra materials are required.
- D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.
- F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the Owner immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the Owner.
- G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Owner and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.
- H. The electrical drawings do not indicate all fittings, hardware, or appurtenances required for a complete operating installation.
- I. Wiring diagrams are not intended to indicate the exact course of raceways.
- J. One-line and riser diagrams are only schematics and do not show physical arrangements of equipment.
- K. All workmanship, including aesthetic as well as electrical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.

- L. Replace or repair, without additional compensation, any Work, which, in the opinion of the Owner, does not comply with these requirements.

3.03 CLEANING & PAINTING OF EQUIPMENT

- A. Refer to Division 09 for additional requirements.
- B. Factory Applied:
  - 1. Electrical equipment shall have factory-applied painting systems, which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
  - 2. Refer to individual sections of this Division for more stringent requirements.
- C. Field Applied: Paint electrical equipment as required to touch up, to match finish on other equipment in adjacent spaces, or to meet safety criteria.
- D. After installation, all metal finishes shall be polished and cleaned of all dirt, rust, cement, plaster, grease, and paint.

**END OF SECTION**

## SECTION 26 05 19

### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

###### B. Related Requirements:

1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
2. Section 260533 "Raceways and Boxes for Electrical Systems"
3. Section 260553 "Identification for Electrical Systems."

##### 1.03 DEFINITIONS

- A. ASTM: American Society of Testing Materials.
- B. ICEA: Insulated Cable Engineers Association.
- C. IEEE: Institute of Electrical & Electronics Engineers.
- D. NEMA: National Electrical Manufacturers Association.
- E. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.
- F. VFD: Variable frequency drive.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each type of product, indicating conductor/cable construction, insulation material, thickness of insulation, jacket, cable stranding, and voltage rating of each type of conductor/cable specified, splices and terminations. Indicate date and place of manufacture for each conductor/cable, cable, splice and termination.
- B. Manufacturer's ISO certification.
- C. Product Cable Schedule: Indicate type, use, location, and termination locations.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Independent Testing Agency.
- B. Field quality-control reports. Perform field testing of cables per para 3.8. Submit six (6) copies of field test reports to owner's representative within two (2) weeks of completion of test.

##### 1.06 QUALITY ASSURANCE

- A. General Requirements: The low voltage power conductors and cable shall be copper, minimum 600V rated unless otherwise indicated. Aluminum conductors and cables shall not be accepted unless otherwise indicated.

- B. Materials and installation shall meet or exceed requirements in the following referenced standards and shall be listed and labelled by UL.
1. ICEA S-95-658/ NEMA WC 70.
  2. UL 1072.
  3. IEEE.
  4. ASTM.
  5. NEMA.
- C. Conductors and cables shall be of the same manufacturer and shipped to the job site in original unbroken reels.
- D. Conductors and cables shall be manufactured with in twelve (12) months of installation. Date of manufacture shall be clearly marked on conductors or conductor reels.
- E. Manufacturer shall have minimum ten (10) years experience in the manufacturer of conductors and cables similar to those specified on this project.
- F. Manufacturer shall have ISO 9001 and ISO 9002 certification.
- G. All conductors and cables shall be new and supplied by a local distributor.
- H. If alternate manufacturer of products other than what are specified in this section are submitted, all necessary documents not limited to cut sheets, technical information, test reports from recognized testing labs and factory test reports shall be submitted to the satisfaction of the owner/engineer to ensure quality and conformance to the specifications. Additional testing shall be undertaken if it is concluded by the owner/engineer that the submitted test reports are either insufficient or do not include all tests necessary for product acceptance. The tests shall be conducted by a recognized lab acceptable to the owner/engineer and all tests shall be witnessed by owner's/engineer's personnel. All testing procedures and test results shall be satisfactory to the owner/engineer. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one owner's/engineer's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- I. Testing: Provide the services of an independent qualified testing laboratory to perform the specified field tests. Notify the University's Representative fourteen (14) days in advance of performance of work requiring testing.
- J. Conductors, cables, splices and terminations shall be manufactured within twelve (12) months of installation. Each item shall have a permanent marking on the product or the original manufacturers' package indicating the date of manufacture unless otherwise noted.
- K. Testing Agency Qualifications:
1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of low voltage electrical power conductors and cables similar to those specified on this project.
  2. Testing company shall be located with 50 miles radius of the project.
  3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
  4. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of low voltage power conductors and cables of the type and rating similar to the conductors and cables to be tested on this project.

## **PART 2 - PRODUCTS**

### **2.01 CONDUCTORS AND CABLES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. General Cable Technologies Corporation.
  2. Southwire Incorporated
  3. Alpha Wire.
  4. Belden Inc.
  5. Encore Wire Corporation.
- B. Conductor Material: Electrical grade, soft drawn annealed copper, 98 percent conductivity, and fabricated in accordance with ASTM and ICEA standards. Minimum size is number 12 for branch circuits, number 14 stranded for control wiring. Aluminum conductors are not permitted. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2 and Type XHHW-2.
- D. Multiconductor Cable: cable assemblies cannot be accepted except for pre-fab manufacturer's furniture and special conditions with written approval of client project management and engineer on record.
- E. VFD Cable:
1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
  2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
  3. Comply with UL requirements for cables in Classes I and II, Division 2 hazardous location applications.
- F. Provide separate neutral with each branch circuit serving outlets. When dedicated neutrals are provided, use color spiral to match associated phase.

### **2.02 CONNECTORS AND SPLICES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Ideal Industries, Inc.
  2. Ilsco
  3. NSi Industries LLC.
  4. O-Z/Gedney; a brand of Emerson Industrial Automation.
  5. 3M; Electrical Markets Division.
  6. TE Connectivity - Raychem.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C. Copper conductors shall be terminated in copper or bronze mechanical connectors or lugs or tool applied compression connections made of copper for all connections except those on wiring devices.

- D. Splices in wires No. 10 and smaller shall be made with twist-on splicing connector in accordance with UL486-C. Connections in wires No. 8 and larger shall be made with compression type connectors in accordance with UL486-A and wrapped with insulated tape in accordance with UL501. Insulating tape shall be applied in a minimum of two layers of half wrap or built to match the overall insulation of the wire.
- E. Splices in underground pull boxes shall be made submersible type and made using "3M" Scotch-cast epoxy kits.
- F. Pressure type connectors are not permitted.

## 2.03 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

## **PART 3 - EXECUTION**

### 3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper, stranded for No. 10 AWG and larger.
- B. Branch Circuits: Copper, Stranded No. 12 AWG and larger; VFD cable, which shall be extra flexible stranded; No. 10 AWG minimum where exterior to the facility's main building.

### 3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway
- B. Exposed Feeders: Type XHHW-2, single conductors in raceway.
- C. Feeders Concealed in interior Ceilings, Walls, Partitions, and Crawlspace at building interior: Type THHN-2-THWN-2 or XHHW-2, single conductors in raceway.
- D. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace at exterior to the facility's main building: Type XHHW-2, single conductors in raceway.
- E. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway
- F. Exposed Branch Circuits at building interior, Including in Crawlspace: Type THHN-2-THWN-2 or XHHW-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions at interior: Type THHN-2-THWN-2 or XHHW-2, single conductors in raceway.
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions at exterior to the facility's main building: Type XHHW-2, single conductors in raceway.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. VFD Output Circuits: Type TC-ER cable with braided shield.

### 3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. All conductors and cables shall be installed in a raceway.

- B. Before installing conductors and cables in existing conduits, verify the continuity of each conduit; each surface conduit is properly supported per code and clear of any debris.
- C. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- G. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- H. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

#### 3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors].
  - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

#### 3.05 IDENTIFICATION

- A. Each conductor shall be factory color coded by conductor manufacturer. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

#### 3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

#### 3.07 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

#### 3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Engage an independent qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:



1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance conductors, feeder conductors and the conductors feeding the following critical equipment and services for compliance with requirements.
  2. Perform each visual and mechanical inspection and electrical tests stated in latest NETA Acceptance Testing Specification section 7.3.2 (Inspection and Test Procedures-Cables, Low Voltage-600V Maximum). Certify compliance with test parameters per NETA tables.
  3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    - i. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    - ii. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - iii. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Test and Inspection Reports: Prepare a written report to record the following:
1. Procedures used.
  2. Results that comply with requirements. Include color scan images.
  3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Cables will be considered defective if they do not pass tests and inspections.

**END OF SECTION**

## SECTION 26 05 26

### GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes: Grounding systems and equipment.
- B. Section includes grounding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.

##### 1.03 DEFINITIONS:

- A. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.
- B. NETA MTS: InterNational Electrical Testing Association - Maintenance Testing Specification.
- C. NFPA : National Fire Protection Association.
- D. IEEE: Institute of Electrical and Electronics Engineers

##### 1.04 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical catalog cuts for each type of product indicated.
- B. Shop Drawings: Site drawings to scale including details showing location and size of each field connection of grounding system.
  - 1. Wiring Diagrams: Differentiate between manufacturer installed and field installed wiring.
- C. Sustainable Design Submittals:
  - 1. Product Data: For each conductor and cable indicating lead content.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Informational Submittals: Plans drawn to scale (1/4"=1'-0") showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
  - 1. Test wells.
  - 2. Ground rods.
  - 3. Grounding conductors, connectors.
- B. Field quality-control reports for client record. Submit written test reports including the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.

##### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells grounding connections for separately derived systems based on NETA MTS.
  - i. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
  - ii. Include recommended testing intervals.

#### 1.07 QUALITY ASSURANCE

##### A. Testing Agency Qualifications:

1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of grounding systems similar to those specified on this project.
2. Testing company shall be located with 50 miles radius of the project.
3. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
4. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of rounding systems of the type and rating similar to the systems to be tested on this project.

##### B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

##### C. Comply with UL 467 for grounding and bonding materials and equipment.

### **PART 2 - PRODUCTS**

#### 2.01 GROUNDING ELECTRODES, CONDUCTORS, CONNECTOR, BUS:

##### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:

1. Grounding Connectors, Bars and Rods:
  - i. Erico - Pentair Electrical Fastening Solutions
  - ii. Burndy – A Hubbell Company.
  - iii. Ideal Industries, Inc.
  - iv. O-Z/Gedney Co. - A brand of Emerson Industrial Automation.
  - v. Thomas & Betts - A Member of the ABB Group.
2. Grounding Conductors and cables:
  - i. Southwire
  - ii. American Insulated Wire
  - iii. Okonite

#### 2.02 CONDUCTORS

##### A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

##### B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.
  3. Tinned Conductors: ASTM B 33.
  4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
  5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
  7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
- D. Lead Content: Less than 300 parts per million

## 2.03 CONNECTORS

- A. Listed and labeled by UL for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors, Rods and Pipes: Copper or copper alloy, pressure type with at least two bolts.
  1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- E. Lead Content: Less than 300 parts per million

## 2.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts
  1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
  2. Backfill Material: Electrode manufacturer's recommended material.

# PART 3 - EXECUTION

## 3.01 APPLICATIONS

- A. Conductors: Install stranded conductors for unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
  1. Bury at least 24 inches (600 mm) below grade.
  2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment or IT rooms, and elsewhere as indicated.
  - 1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
  - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.02 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Install #4/0 bare copper ground wire loop around the outside perimeter of the manhole, in soil, 12" above bottom of manhole. Cadweld ground wire loop to #4/0 bare copper ground wire connecting all exposed metal parts inside the manhole through a 1" opening at the top of manhole wall. Seal and waterproof opening after wire installation.
- D. Grounding Connections to Manhole Components: Bond exposed metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- E. Pad-Mounted Transformers and Medium Voltage Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 1/0 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

### 3.03 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits in the same conduit containing phase and neutral conductors. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70. :
1. Feeders and branch circuits.
  2. Lighting circuits.
  3. Receptacle circuits.
  4. Single-phase motor and appliance branch circuits.
  5. Three-phase motor and appliance branch circuits.
  6. Flexible raceway runs.
  7. Armored and metal-clad cable runs.
  8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
  9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- G. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
  2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
  3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
  4. All metallic conduits and cable tray shall be continuously bonded to maintain low resistance ground path and bonded back to the central equipment by the use of bonding jumpers where needed.

- H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode next to the pole and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors. Provide a handhole for the grounding electrode at each pole.
- I. Metallic Fences or Other Metal Structures: Comply with requirements of IEEE C2. Bond metallic fences and other metal structures located within 8 feet (2.5 m) vertically or 16 feet (5 m) horizontally of exposed conductors or equipment.
1. Grounding Conductor: Bare, tinned-copper, not less than No. 8 AWG.
  2. Gates: Shall be bonded to the gate support post with a flexible bonding jumper. Bond each gate support post to the grounding electrode system in the area.
  3. Provide bond across fence openings with 2 AWG bonding jumper buried 18 inches (460 mm) minimum below finished grade. Extend local grounding electrode system to cover swing of gates.
  4. Barbed Wire: Strands shall be bonded to the grounding conductor.
- J. Generator (Non-Separately Derived System): Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator. Maintain separation of neutral and ground. Provide warning sign at neutral to ground bond location: "WARNING: SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE IS ENERGIZED."

### 3.04 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade using exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  2. For grounding electrode system, install ground rods at least three rods (unless otherwise indicated on the drawings), spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
  2. Test Wells near light poles: Coordinate location with landscape drawings and install one at each pole. Test well shall be open bottom and installed on a 12"H bed of gravel or crushed stone (1" size).

- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  2. Separately Derived System (SDS): All multiple branch metal water piping laterals originating from outside the area being served by the SDS and which serve the same area being served by the SDS shall be bonded to the common grounding electrode (GE) or the common grounding electrode conductor (GEC). The bonding connection shall be made at each level that the metal water piping serves. When multiple SDS's are installed or an SDS serves multiple levels of a structure, a copper common GEC shall be installed for the SDS as permitted in NFPA 70 article 250.30 (D)3 and sized per article 250.30 (A) and (B).
  3. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  4. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
  2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

### 3.05 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."



### 3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Engage an independent qualified testing agency to perform tests and inspections. Refer to section
- B. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - i. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - ii. Perform tests by fall-of-potential method according to IEEE 81.
  - 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
  - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
  - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
  - 5. Substations and Pad-Mounted Equipment: 5 ohms.
  - 6. Manhole Grounds: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

**END OF SECTION**

## SECTION 26 05 29

### HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

##### 1.03 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

##### 1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of per structural plans.

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
  - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel slotted channel systems. Include Product Data for components.
  - 3. Nonmetallic slotted channel systems. Include Product Data for components.
  - 4. Equipment supports.

##### 1.06 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.07 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.08 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

**PART 2 - PRODUCTS**

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Allied Tube & Conduit: Part of Atkore International
    - ii. Cooper B-Line, Inc.; a division of Eaton Inc.
    - iii. ERICO International Corporation
    - iv. GS Metals Corp.
    - v. Thomas & Betts Corporation; A Member of the ABB Group.
    - vi. Unistrut; Part of Atkore International,
    - vii. Wesanco, Inc.
  - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: not applicable to project.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - i. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - ii. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - i. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
  3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  6. Toggle Bolts: All-steel springhead type.
  7. Hanger Rods: Threaded steel.

## 2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## **PART 3 - EXECUTION**

### **3.01 APPLICATION**

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as per structural designs; where necessary, as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 30 percentage in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.

### **3.02 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
  - 6. To Light Steel: Sheet metal screws.
  - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### **3.03 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.05 PAINTING

- A. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting", and Section 099600 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION**

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## SECTION 26 05 33

### RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

###### B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
3. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

##### 1.03 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. EMT: Electrical metal tubing
- C. ENT: Electrical non-metallic tubing
- D. GRC: Galvanized rigid steel conduit.
- E. HDPE: High density polyethylene pipe
- F. IMC: Intermediate metal conduit.
- G. LFMC: Liquidtite flexible metal conduit
- H. LFNC: Liquidtite flexible non-metallic conduit.
- I. RNC: Rigid non-metallic conduit
- J. RTRC: Reinforced thermosetting resin conduit

##### 1.04 QUALITY ASSURANCE:

- A. Each conduit shall bear manufacturer's trademark and UL label.



- B. Each type of conduit and fittings shall be of a single manufacturer. Multiple manufacturer's of the same material are not acceptable.
- C. Comply with California Electric Code (CEC)

1.05 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

**PART 2 - PRODUCTS**

2.01 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 2. Electri-Flex Company.
  - 3. O-Z/Gedney; a brand of EGS Electrical Group.
  - 4. Republic Conduit.
  - 5. Robroy Industries.
  - 6. Thomas & Betts Corporation.
  - 7. Western Tube and Conduit Corporation.
  - 8. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be UL listed and labeled as defined in NFPA 70, and marked for intended location and application.

- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit -
  - 1. Comply with ANSI C80.1 ETL PVC-001, NEMA RN 1 and UL 6.
  - 2. Coating Thickness: 0.040 inch, minimum.
  - 3. A PVC Coated Sealing Locknut shall be used on all exposed male threads transitioning into female NPT threads which do not have sealing sleeves, including transitions from PVC couplings/female adapters to PVC coated GRC elbows in direct burial applications. PVC Coated Sealing Locknuts are not to be used in place of a conduit hub.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. FMC: Comply with UL 1; zinc-coated / galvanized steel.
- I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:
    - i. Material: Steel.
    - ii. Type: compression.
  - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- K. PVC-Coated Fittings:
  - 1. Fittings shall be Form 8 with a V-Seal tongue-in-groove gasket and supplied with plastic encapsulated stainless steel cover screws. Form 8 fittings shall be UL Type 4X listed and IEC IP69 certified. Fittings shall be from the same manufacturer as the conduit in order to maintain system continuity and warranty. PVC Coated fittings for hazardous locations must be UL 1203 listed.
- L. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CANTEX Inc.
  - 2. Condux International, Inc.
  - 3. Electri-Flex Company.
  - 4. Lamson & Sessions; Carlon Electrical Products.
  - 5. RACO; a Hubbell company.

6. Thomas & Betts Corporation.

- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. RTRC: Comply with UL 1684A and NEMA TC 14.
- F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Fittings for LFNC: Comply with UL 514B.
- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; a brand of Schneider Electric.
  - 2. Cooper B-Line, Inc
  - 3. Hoffman; a Pentair company.
  - 4. Mono-Systems, Inc.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 and 3R unless otherwise indicated, and sized according to NFPA 70.
  - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type and Flanged-and-gasketed type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.04 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be UL listed and labeled as defined in NFPA 70, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Wiremold / Legrand.
    - ii. Hubbell Wiring Systems
    - iii. Mono-Systems, Inc.
    - iv. Panduit Corp.

## 2.05 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hoffman; a Pentair company.
  2. EGS/Appleton Electric.
  3. Hubbell Incorporated; Killark Division.
  4. O-Z/Gedney; a brand of EGS Electrical Group.
  5. RACO; a Hubbell Company.
  6. Robroy Industries.
  7. Thomas & Betts Corporation.
  8. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
1. Material: Cast metal.
  2. Type: Fully adjustable or Semi-adjustable.
  3. Shape: Rectangular.
  4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
1. Listing and Labeling: Paddle fan outlet boxes shall be UL listed and labeled as defined in NFPA 70, and marked for intended location and application.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- L. Gangable boxes are prohibited.
- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:

1. NEMA 250, Type 1 and Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.06 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. Jensen Precast Inc.
  - ii. CDR Systems Corporation; Hubbell Power Systems.
  - iii. Oldcastle Precast, Inc.; Christy Concrete Products.
  - iv. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
2. Standard: Comply with SCTE 77.
  3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  6. Cover Legend: Molded lettering, "ELECTRIC." Boxes containing conductors and cables over 600V, the cover shall include permanently engraved name of the utility company (e.g. UCSD), type of utility (e.g. ELECTRIC), DANGER-HIGH VOLTAGE-KEEP OUT" in minimum 1/2" inch size, block letters.
  7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  8. Handholes 12 Inches Wide by 17 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.07 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
  2. Concealed Conduit, Aboveground: GRC. Use EPC-40PVC inside concrete walls and columns only.
  3. Underground Conduit: Type EPC-40-PVC, including concrete encased. Type EPC-80-PVC, under slab.
  4. Connection to Vibrating Equipment (Including Transformers, Inverters, Hydraulic, Inverters, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed, Not Subject to Severe Physical Damage: EMT.
  3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    - i. Loading dock.
    - ii. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - iii. Mechanical rooms.
  4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  5. Concealed in concrete walls and columns: RNC Type EPC-40-PVC.
  6. Connection to Vibrating Equipment (Including Transformers, Inverters, Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations. 72inch max
  7. Damp or Wet Locations: GRC.
  8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings and with respect to existing conditions.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

I. Standards:

1. Outdoor locations above grade: provide galvanized rigid steel conduit. Locations above 30" at vehicle traffic and penetrations into existing building walls: provide either IMC or RGS.
2. In slab: provide PVC schedule 80 conduit.
3. Wet and damp locations: provide either IMC or RGS with sealed connections – compression/threaded.
4. Exposed dry locations: provide galvanized rigid steel conduit. EMT may be used in areas 10' above finished grade or floor.
5. Concealed dry locations protected from damage: provide EMT.
6. Minimum conduit size shall be 3/4".
7. Provide pull ropes in data conduits.
8. Provide compression type fittings

### 3.02 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

5. Change from ENT to PVC coated GRC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes with PVC touch-up compound after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly. All installers shall be certified by the manufacturer and be able to present a valid unexpired installer certification card prior to installation beginning.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 250lbs (113 kgs) tensile strength. Leave at least 12 inches of slack at each end of pull wire. Provide acrylic identification tags (2"X4") at each end indicating the source. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
  2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service raceway enters a building or structure.



3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- W. Expansion-Joint Fittings:
  1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - i. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - ii. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - iii. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - iv. Attics: 135 deg F temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, , equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  1. Use LFMC in damp or wet locations.
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to drawing details of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.03 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - i. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - ii. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

### 3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances. Top of conduits inside the handhole/box shall be minimum 4 inches above the bottom of the handhole/box.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel (minimum 6 inch high), graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.06 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.07 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION**

## SECTION 26 05 36

### CABLE TRAYS FOR ELECTRICAL SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:

1. Ladder cable trays.
2. Trough cable trays.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

- B. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings between trades: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved. Requirements per construction management
- B. Seismic Qualification Certificates for record to client: For cable trays, accessories, and components, from manufacturer.

#### **PART 2 - PRODUCTS**

##### 2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer " to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
  2. Component Importance Factor: 1.5.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
  1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 2.02 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
  - 1. Source Limitations: Obtain cable trays and components from single manufacturer, per type.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
  - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
  - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
  - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

## 2.03 LADDER CABLE TRAYS - Interior

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper B-Line, Inc.
  - 2. Chatsworth Products Inc.
  - 3. Hoffman Pentair
- B. Description:
  - 1. Configuration: Two 1-1/2" x 3/8" 16-gauge tubular steel side rails with transverse rungs welded to side rails.
  - 2. Rung Spacing: 9 inches O.C.
  - 3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
  - 4. Minimum Cable-Bearing Surface for Rungs: 1-inch width with radius edges.
  - 5. No portion of the rungs shall protrude below the bottom plane of side rails.
  - 6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1, Section 5.4.
  - 7. Straight Section Lengths: 9 feet 11.5 inches except where shorter lengths are required to facilitate tray assembly.
  - 8. Width: 12 inches unless otherwise indicated on Drawings.
  - 9. Fitting Minimum Radius: 12 inches.
  - 10. Splicing Assemblies: Bolted type using serrated flange locknuts.
  - 11. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

## 2.04 TROUGH CABLE TRAYS – Exterior roof

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
  - 1. Site-pro 1 SP1543D is basis:

- a. Cover Height is 8-1/4"
- b. Cover Size - 21-1/2" x 8'
- c. # Holes for Snap-Ins = 8 (stack up to (16) 1-5/8" cables, or (24) 7/8" cables)
- d. Taller rooftop cover kits to accept stackable style snap-ins.
- e. Stack up to two 1-5/8" snap-ins or three 7/8" snap-ins.

Include complete system: Kits, mounting, Eaton-cooper B-line supports, and pitch hardware (B634)

## 2.05 MATERIALS AND FINISHES

### A. Steel:

- 1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
- 2. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
- 3. Finish: Hot-dip galvanized (exteriors).
  - a. Standard: Comply with ASTM A 123/A 123M, Class B2/ASTM A1008, Grade 33, Type 2.
  - b. Hardware: Chromium-zinc plated, ASTM F 1136.
- 4. Finish: Powder-coat enamel paint (interiors).
  - a. Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
  - b. Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
  - c. Epoxy-Resin Topcoat: Epoxy, cold-cured, gloss, MPI# 77.
  - d. Hardware: Chromium-zinc plated, ASTM F 1136.

### B. Aluminum:

- 1. Materials: Alloy 6063-T6 according to ANSI H 35.1/H 35.1M for extruded components and Alloy 6061-T6 according to ANSI H 35.1/H 35.1M for fabricated parts.
- 2. Hardware: Chromium-zinc-plated steel, ASTM F 1136.

## 2.06 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: Solid type made of same materials and with same finishes as cable tray.
- C. Barrier Strips: Same materials and finishes as for cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

## 2.07 WARNING SIGNS

- A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not to Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

## 2.08 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

## **PART 3 - EXECUTION**

### 3.01 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure and install seismic restraints.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- O. Make changes in direction and elevation using manufacturer's recommended fittings.
- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.
- T. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

- U. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- V. Install warning signs in visible locations on or near cable trays after cable tray installation.

### 3.02 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

### 3.03 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).
- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

### 3.04 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

### 3.05 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
  - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
  - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.



4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorquing in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

### 3.06 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

**END OF SECTION**

## SECTION 26 05 43

### UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes the following:
  - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct bank(s)
  - 2. Handholes and boxes.
  - 3. Manholes.
- B. Related Requirements:
  - 1. Section 260526 "Grounding and Bonding of Electrical Systems".

##### 1.03 DEFINITION

- A. RNC: Rigid nonmetallic conduit.
- B. PVC coated GRS: PVC coated Galvanized rigid steel conduit
- C. PVC: Poly Vinyl Chloride
- D. NETA: InterNational Testing Association

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Duct-bank materials, including separators and miscellaneous components.
  - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Accessories for manholes, handholes, boxes, and other utility structures.
  - 4. Warning tape.
  - 5. Warning planks.
  - 6. Pull ropes.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
  - 1. Duct entry provisions, including locations and duct sizes.
  - 2. Reinforcement details.
  - 3. Frame and cover design and manhole frame support rings.
  - 4. Ladder details.
  - 5. Grounding details.
  - 6. Cable racks, insert. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

7. Joint details.

1.05 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
  - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
  - 2. Drawings shall be signed and sealed by a qualified California registered professional electrical engineer.
- B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858. Certificates shall be signed by manufacturer's structural engineer. Include name and date.
- C. Qualification Data: For professional engineer and testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.
- D. Each conduit shall bear manufacturer's trademark and UL label. Conduits and fittings shall be of a single manufacturer. Multiple manufactures for the same material are not acceptable.
- E. Comply with California Electric Code (CEC).

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Deliver precast concrete manholes, handholes and other underground utility structures when the site is ready for installation. Store precast concrete and other factory-fabricated underground utility structures at project site (if necessary) as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.08 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Construction Manager and Owner no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.
  - 3. Existing electrical service shall be shut down by owner's authorized personnel. Coordinate with owner in advance.

1.09 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

## **PART 2 - PRODUCTS**

### **2.01 CONDUIT**

- A. Plastic-Coated Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1. Plastic-Coated Rigid Steel Conduit and Fittings: Rigid steel conduit and fittings with an extruded polyvinyl chloride jacket, minimum 40 mils. The jacket shall have high tensile strength, shall be highly resistant to corrosion and shall not oxidize or deteriorate or shrink when exposed to sunlight and weather. The jacket shall be flame retardant and shall not support combustion. The interior of the conduit shall have a urethane coating, minimum 2 mils.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Tube and Conduit
  - 2. Republic Conduit
  - 3. Western Tube
- C. RNC: Heavy wall design; NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B. Make all fittings watertight with solvent-weld recommended by the conduit manufacturer and specifically manufactured for the purpose.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cantex, Inc.
  - 2. Thomas & Betts-Carlon
  - 3. Lamson & Sessions -Carlon Division
  - 4. JM Eagle
  - 5. Allied Tube and Conduit
  - 6.
- E. Split conduits/ducts and other non-UL approved ducts systems shall not be acceptable.

### **2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Tube and Conduit
  - 2. Cantex, Inc.
  - 3. Lamson & Sessions; Carlon Electrical Products.
- B. Duct Accessories:
  - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.

2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
  - i. Color: Red dye added to concrete during batching.
  - ii. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

#### 2.03 FLEXIBLE NONMETALLIC DUCTS

1. Flexible duct not acceptable.

#### 2.04 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Christy Concrete Products.
  2. Oldcastle Precast Group.
  3. Jensen Precast
- C. Comply with ASTM C 858 for design and manufacturing processes.
- D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have traffic load rating consistent with that of handhole or box.
  1. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
  2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  3. Cover Legend: Molded lettering, "ELECTRIC." "TELEPHONE." "GROUNDING"
  4. Configuration: Units shall be designed for flush burial and have closed integral closed bottom, unless otherwise indicated.
  5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
    - i. Extension shall provide increased depth of 12 inches (300 mm).
    - ii. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
  6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
    - i. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    - ii. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    - iii. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct are acceptable where field verified by contractor.
  - i. Type and size shall match fittings to duct or conduit to be terminated.
  - ii. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
8. Handholes 12 inches wide by 18 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.05 PRECAST MANHOLES

- A. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

## 2.06 UTILITY STRUCTURE ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Bilco Company (The).
  2. Christy Concrete Products.
  3. Jensen Precast
  4. Neenah Foundry Company.
  5. Oldcastle Precast Group.
  6. Underground Devices, Inc.
  7. Utility Concrete Products, LLC.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
  1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B, 29 inches (737 mm).
    - i. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    - ii. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
  2. Cover Legend: Cast in. Selected to suit system.
    - i. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
    - ii. Legend: "ELECTRIC-HV"; "Manhole/Handhole number as indicated on the drawings" for duct systems with medium-voltage cables.
    - iii. Legend: "SIGNAL"; "Manhole/Handhole number as indicated on the drawings" for communications, data, and telephone duct systems.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
  1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- D. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.

- E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
- H. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
1. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
  2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
  3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- I. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
  2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.
- J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

## 2.07 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.01 STANDARDS

- A. Conduit Applications:

1. Underground, more than 5 feet outside foundation wall: provide PVC schedule 40 or PVC-coated rigid steel conduit.
  2. Underground, within 5 feet from foundation wall: provide PVC coated rigid steel conduit.
  3. In or under slab on grade (eg Generator service yard): provide PVC schedule 80 conduit.
- B. Minimum conduit size underground shall be 1".
- C. Provide pull ropes in all conduits.

### 3.02 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80 (drive areas), EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 (drive areas), EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Bored Underground Duct: Type EPEC-40-HDPE, Type EPEC-80-HDPE (drive areas), unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- F. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in duct bank, unless otherwise indicated.
- G. Underground Ducts Crossing Paved Paths Walks and Driveways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

### 3.03 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
  2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
  3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
  4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
- B. Manholes: Precast concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

### 3.04 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.



- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Section 017329 "Cutting and Patching."

### 3.05 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 30 inches (1220 mm) and angled sweep entries (where permissible by code) for horizontal runs, unless specifically noted otherwise. Conduits shall be configured for each of constructibility and effective for future replacements.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
  - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
  - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
  - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid PVC coated steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- F. Do not install conduits underneath a building except where the service/feeder/branch circuit conduits enter the building.
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psi (1.03-MPa) hydrostatic pressure.
- H. Pulling Cord: Install minimum 1/8 inch thick test nylon cord with minimum 250 pounds per foot tensile strength in ducts, including spares.
- I. Concrete-Encased Ducts: Support ducts on duct separators.
  - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

- i. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
  - ii. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Encase all feeder ducts in a 3 inch concrete envelope. Extend envelope with 3 inches beyond all external surfaces of all outer most ducts. Do not over pour the concrete.
5. Concrete encasement shall be minimum 3000 psi. All underground ducts containing MV and HV cables (above 600V) shall be encased in red concrete. Concrete shall be premixed during batching with 1-1/2 lbs of red ochre dye per sack of cement.
6. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
7. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
8. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, and 12 inches (300 mm) between power and signal ducts.
9. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated. Minimum depth below grade in all areas shall be 36 inches (900 mm) for underground ducts containing MV and HV ducts.
10. Stub-Ups: Use manufactured PVC coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  - i. Couple PVC coated steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
11. Warning Tape: Bury warning tape approximately 12 inches (300 mm) below grade above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

J. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.

3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
4. Install backfill as specified in Section 312000 "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 12 inches (300 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured PVC coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  - i. Couple PVC coated steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
  - ii. For equipment mounted on outdoor concrete bases, extend PVC coated steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
10. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

### 3.06 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

#### A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of 12 inches thick crushed gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

#### B. Elevations:

1. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
2. Where indicated, cast handhole cover frame integrally with handhole structure.

#### C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

#### D. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Div 071354

Waterproofing. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

- E. Dampproofing: Apply dampproofing to exterior surfaces of manholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Div 07 "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

### 3.07 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.08 FIELD QUALITY CONTROL

- A. During construction, partially completed duct lines shall be protected from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of a duct line is completed from manhole to vault, a testing mandrel not less than 12 inches long with a diameter 1/4-inch less than the size of the duct, shall be drawn through each duct, after which a brush having the diameter of the duct, and have stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand, gravel and other foreign materials. Conduit plugs shall then be immediately installed. Underground conduits, which terminate inside the building below grade, or which slope so that water might flow into building, shall be sealed at termination after installation of wires.
- B. Perform the following tests and inspections and prepare test reports:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
  - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
  - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Correct deficiencies and retest as specified above to demonstrate compliance.

### 3.09 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

## **END OF SECTION**

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## SECTION 26 05 44

### SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

###### B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

##### 1.03 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

###### B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

#### **PART 2 - PRODUCTS**

##### 2.01 SLEEVES

###### A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

###### B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

###### C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

###### D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

###### E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

###### F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
  - i. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
  - ii. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

## 2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
    - i. Advance Products & Systems, Inc.
    - ii. CALPICO, Inc.
    - iii. Metraflex Company (The).
    - iv. Pipeline Seal and Insulator, Inc.
    - v. Proco Products, Inc.
    - vi. 3M
  2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  3. Pressure Plates: Stainless steel.
  4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
    - i. Presealed Systems.
    - ii. Metraflex

## 2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
  2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

### **PART 3 - EXECUTION**

#### **3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS**

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - i. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - ii. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.



- G. Underground, Exterior-Wall and Floor Penetrations: Install PVC Coated cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

**END OF SECTION**

## SECTION 26 05 48

### VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes the following:

- 1. Isolation pads.

##### 1.03 DEFINITIONS

- A. The CBC: California Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

##### 1.04 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:

- 1. Site Class as Defined in the CBC: D.
  - 2. Assigned Seismic Use Group or Building Category as Defined in the CBC: II.
    - i. Component Importance Factor: 1.0.
    - ii. Component Response Modification Factor: Per ASCE 7-05 Table 13.6-1.
    - iii. Component Amplification Factor: Per ASCE 7-05 Table 13.6-1.
  - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second):  $SDS = 1.00g$ .
  - 4. Design Spectral Response Acceleration at 1.0-Second Period:  $S1S = 0.60g$ .

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For the following:

- 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    - i. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    - ii. Annotate to indicate application of each product submitted and compliance with requirements.
  - 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

- B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
  - i. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.
2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:
  - i. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
  - ii. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
  - iii. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Field quality-control test reports.
- E. Catalog cuts and data sheets on specific vibration isolators, mufflers, electrical box pads and other equipment to be utilized showing compliance with the specification.
  1. An itemized list showing the items of equipment to be isolated, the isolator type and model number selected, isolator loading and deflection.
  2. The Contractor shall obtain written instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices and seismic restraints.

#### 1.07 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based

on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Comply with NFPA 70.

## **PART 2 - PRODUCTS**

### **2.01 VIBRATION ISOLATORS**

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Ace Mountings Co., Inc.
  - 2. Amber/Booth Company, Inc.
  - 3. California Dynamics Corporation.
  - 4. Isolation Technology, Inc.
  - 5. Kinetics Noise Control.
  - 6. Mason Industries.
  - 7. Vibration Eliminator Co., Inc.
  - 8. Vibration Isolation.
  - 9. Vibration Mountings & Controls, Inc.
- C. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
  - 1. Resilient Material: Oil- and water-resistant neoprene.
- D. Equipment Isolation Requirements:
  - 1. Floor Mounted Transformers: Isolator Type A. Minimum static deflection 0.2".
  - 2. Liquid-filled Transformers: Isolator Type A.
  - 3. UPS: Isolator Type A. Minimum static deflection 0.2".
- E. Isolator Type Information:
  - 1. Type A: Neoprene pad. Waffle, ribbed, or other forms. Typically 1/4 to 5/16 inch thick. Durometers of 40-65. Static deflections from 0.01 to 0.07 inches. Nominal design 40 durometer for 0.05 inches static deflection. Provide steel load distribution plates. Size of pad to be specified by isolator supplier base on load per pot. Mason W and WM, Vibrex R, or equal.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

### 3.03 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
  - 1. Install restrained isolators on electrical equipment.
  - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

### 3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
  - 6. Measure isolator restraint clearance.
  - 7. Measure isolator deflection.
  - 8. Verify snubber minimum clearances.
  - 9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

### 3.06 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

### 3.07 VIBRATION ISOLATION DEVICES

- A. Transmission of perceptible vibration or structure borne noise to occupied areas by equipment installed under this Contract will not be permitted.
- B. Vibration isolators shall be installed per manufacturer's directions.
- C. Use of vibration isolators for lighting inverter and UPS shall be coordinated with lighting inverter supplier.
- D. Flexible electrical connections:
  - 1. Installation of flexible electrical connections to vibration isolated equipment shall in no way impair or restrain the function of the aforementioned vibration isolation.
  - 2. Option 1: Install the flexible conduit in a grossly slack loop form or shallow "U" form. Install the stranded conductors with sufficient slack to accommodate maximum possible movement.

3. Option 2: The flexible coupling shall be free and not in contact with any nearby building construction and shall be installed slack and free of strain in any direction. Install stranded conductors as above.
- E. All vibration isolation devices, including auxiliary steel bases shall be designed and furnished by a single manufacturer or supplier, who will be responsible for adequate coordination of all phases of this work.
- F. The vibration isolation manufacturer, or his representative, shall be responsible for providing such supervision as may be necessary to assure correct installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer, or his representative, shall make a final inspection and submit his report to the Architect in writing, certifying the correctness of installation and compliance with approved submittal data.

3.08 COORDINATION

- A. The contractor shall coordinate his work with other trades to avoid rigid contact between isolated equipment and raceways with the building. He shall inform other trades following his work to avoid any contact which would reduce the vibration isolation.

**END OF SECTION**

## SECTION 26 05 53

### IDENTIFICATION FOR ELECTRICAL SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

##### 1.03 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

###### B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

###### C. Delegated-Design Submittal: For arc-flash hazard study.

#### **PART 2 - PRODUCTS**

##### 2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E and Section 26 0573 "Short Circuit, Coordination and Arc-Flash Study" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.



G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.02 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service' feeder and branch-circuit conductors.

1. Color shall be factory applied.
2. Colors for 208/120-V Circuits:
  - i. Phase A: Black.
  - ii. Phase B: Red.
  - iii. Phase C: Blue.
3. Colors for 240-V Circuits:
  - i. Phase A: Black.
  - ii. Phase B: Red.
4. Colors for 480/277-V Circuits:
  - i. Phase A: Brown.
  - ii. Phase B: Orange.
  - iii. Phase C: Yellow.

5. Color for Neutral: White.
6. Color for Equipment Grounds: Green.
7. Colors for Isolated Grounds: Green with white stripe.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

F. Equipment Identification Labels:

1. Black letters on a white field for equipment connected to normal power and Red letters on a white field for equipment connected to emergency/standby power unless otherwise indicated

## 2.03 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Brady Corporation.
    - ii. HellermannTyton.
    - iii. Marking Services, Inc.
    - iv. Panduit Corp.
    - v. Seton Identification Products.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Brady Corporation.
    - ii. HellermannTyton.
    - iii. Marking Services, Inc.
    - iv. Panduit Corp.
    - v. Seton Identification Products.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyesterflexible label with acrylic pressure-sensitive adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Brady Corporation.
    - ii. Grafoplast Wire Markers.
    - iii. Ideal Industries, Inc.
    - iv. Marking Services, Inc.
    - v. Panduit Corp.
    - vi. Seton Identification Products.
  2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Brady Corporation.
    - ii. Grafoplast Wire Markers.
    - iii. HellermannTyton.

- iv. Ideal Industries, Inc.
- v. Marking Services, Inc.
- vi. Panduit Corp.
- vii. Seton Identification Products.

2. Minimum Nominal Size:

- i. 1-1/2 by 6 inches for raceway and conductors.
- ii. 3-1/2 by 5 inches for equipment.
- iii. As required by authorities having jurisdiction.

2.04 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. Brady Corporation.
- ii. HellermannTyton.
- iii. Marking Services, Inc.
- iv. Panduit Corp.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. Brady Corporation.
- ii. Panduit Corp.

2.05 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. Carlton Industries, LP.
- ii. HellermannTyton.
- iii. Ideal Industries, Inc.
- iv. Marking Services, Inc.
- v. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- i. Brady Corporation.
- ii. Carlton Industries, LP.

- iii. emedco.
  - iv. Marking Services, Inc.
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. HellermannTyton.
    - ii. LEM Products Inc.
    - iii. Marking Services, Inc.
    - iv. Seton Identification Products.
- D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Carlton Industries, LP.
    - ii. Seton Identification Products.
- E. Underground-Line Warning Tape:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Brady Corporation.
    - ii. Ideal Industries, Inc.
    - iii. Marking Services, Inc.
    - iv. Seton Identification Products.
  - 2. Tape:
    - i. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
    - ii. Printing on tape shall be permanent and shall not be damaged by burial operations.
    - iii. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  - 3. Color and Printing:
    - i. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    - ii. Inscriptions for Red-Colored Tapes: "CAUTION BURIED ELECTRIC LINE, HIGH VOLTAGE" .
    - iii. Inscriptions for Orange-Colored Tapes: "CAUTION BURIED TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE" .
  - 4. Tag: Type IID:

- i. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
  - ii. Width: 6 inches.
  - iii. Overall Thickness: 5 mils.
  - iv. Foil Core Thickness: 0.35 mil.
  - v. Weight: 34 lb/1000 sq. ft..
  - vi. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be inch unless otherwise indicated. If requested by Architect, match Owner's existing legend type, size etc.

## 2.06 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Brady Corporation.
    - ii. Carlton Industries, LP.
    - iii. emedco.
    - iv. Marking Services, Inc.
    - v. Seton Identification Products.

## 2.07 SIGNS

- A. Baked-Enamel Signs:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Carlton Industries, LP.
    - ii. Champion America.
    - iii. emedco.
    - iv. Marking Services, Inc.
  - 2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
  - 3. 1/4-inch grommets in corners for mounting.
  - 4. Nominal Size: 7 by 10 inches.
- B. Metal-Backed Butyrate Signs:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Brady Corporation.
    - ii. Champion America.
    - iii. emedco.

- iv. Marking Services, Inc.
  - 2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
  - 3. 1/4-inch grommets in corners for mounting.
  - 4. Nominal Size: 10 by 14 inches.
- C. Laminated Acrylic or Melamine Plastic Signs:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Brady Corporation.
    - ii. Carlton Industries, LP.
    - iii. emedco.
    - iv. Marking Services, Inc.
  - 2. Engraved legend.
  - 3. Thickness:
    - i. For signs up to 20 sq. in., minimum 1/16 inch thick.
    - ii. For signs larger than 20 sq. in., 1/8 inch thick.
    - iii. Engraved legend with black letters on white face background for equipment connected to normal power and red letters on white face background for equipment connected to emergency/standby power. Verify with Architect if legend has to match Owner's existing signs.
    - iv. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
    - v. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.08 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. HellermannTyton.
  - 2. Ideal Industries, Inc.
  - 3. Marking Services, Inc.
  - 4. Panduit Corp.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
- 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
  - 3. Temperature Range: Minus 40 to plus 185 deg F.
  - 4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
- 1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
  3. UL 94 Flame Rating: 94V-0.
  4. Temperature Range: Minus 50 to plus 284 deg F.
  5. Color: Black.

## 2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## 2.10 STANDARDS

- A. Raceway and Metal-Clad Cable Identification:
1. Adhesive labels and warning tape for underground lines.
- B. Conductor and Cable Identification:
1. Colored adhesive tape and brass or aluminum tags.
- C. Equipment Labels: engraved plastic attached with rivets or screwed on.
1. Warning Signs: Baked enamel and metal backed butyrate.
  2. Instruction Signs: Engraved, laminated acrylic or melamine plastic.

# **PART 3 - EXECUTION**

## 3.01 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

## 3.02 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.

- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer. Refer to drawings for additional information.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- M. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
  - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.



1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
  2. Limit use of underground-line warning tape to direct-buried cables.
  3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- X. Metal Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using general-purpose UV-stabilized cable ties for all area except use plenum-rated cable ties in plenum areas.
- Y. Nonmetallic Preprinted Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using general-purpose UV-stabilized in all areas except use plenum-rated cable ties in plenum areas.
- Z. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.
- AA. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- BB. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- CC. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
  2. In Spaces Handling Environmental Air: Plenum rated.

### 3.03 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch-high, black letters on 20-inch centers.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals unless otherwise indicated.
- D. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- J. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- K. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- L. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- M. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
  2. Wall surfaces directly external to raceways concealed within wall.
  3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- N. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- O. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- P. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.
1. Apply to exterior of door, cover, or other access.
  2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
    - i. Power-transfer switches.
    - ii. Controls with external control power connections.
- Q. Arc Flash Warning Labeling: Self-adhesive labels.
- R. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- S. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- T. Equipment Identification Labels:
1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
  2. Outdoor Equipment: Laminated acrylic or melamine sign. Stenciled legend 4 inches high shall also be provided when requested by Architect.
  3. Equipment to Be Labeled:
    - i. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
    - ii. Enclosures and electrical cabinets.
    - iii. Access doors and panels for concealed electrical items.
    - iv. Switchgear.
    - v. Switchboards.
    - vi. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    - vii. Substations.
    - viii. Emergency system boxes and enclosures.
    - ix. Motor-control centers.
    - x. Enclosed switches.

- xi. Enclosed circuit breakers.
- xii. Enclosed controllers.
- xiii. Variable-speed controllers.
- xiv. Push-button stations.
- xv. Power-transfer equipment.
- xvi. Contactors.
- xvii. Remote-controlled switches, dimmer modules, and control devices.
- xviii. Battery-inverter units.
- xix. Battery racks.
- xx. Power-generating units.
- xxi. Monitoring and control equipment.
- xxii. UPS equipment.

**END OF SECTION**

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## SECTION 26 05 73

### SHORT CIRCUIT, COORDINATION AND ARC FLASH STUDIES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes computer-based, fault-current, overcurrent protective device coordination studies and arc flash study. Protective devices shall be set based on results of the protective device coordination study.

##### 1.03 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."

##### 1.04 ACTION SUBMITTALS

###### A. COORDINATION STUDIES

1. Product Data: For computer software program to be used for studies.
2. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form if requested by the architect/engineer.
3. Coordination-study input data, including completed computer program input data sheets.
4. Study and Equipment Evaluation Reports.
5. Coordination-Study Report.

###### B. SHORT CIRCUIT STUDIES

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.

- i. Short-circuit study input data, including completed computer program input data sheets.
- ii. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
- iii. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

#### C. ARC FLASH STUDIES

1. Product Data: For computer software program to be used for studies.
2. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
  3. Arc-flash study input data, including completed computer program input data sheets.
  4. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For power systems analysis specialist.
- B. Product Certificates: For coordination-study, fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.
- D. Power Systems Analysis Software Developer
- E. Qualification Data: For Field Adjusting Agency

#### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
  1. The following are from the Coordination Study Report:
    - i. Final one-line diagram.
    - ii. Final protective device coordination study.
    - iii. Coordination study data files.
    - iv. List of all protective device settings.
    - v. Time-current coordination curves.
    - vi. Power system data.
  2. The following are from the Short-Circuit Study Report:
    - i. Final one-line diagram.
    - ii. Final Short-Circuit Study Report.
    - iii. Short-circuit study data files.
    - iv. Power system data
  3. The following are from the Arc Flash Hazard Report:
    - i. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
    - ii. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance

procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

#### 1.07 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Power Systems Analysis Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.
- E. Field Adjusting Agency Qualifications:
  - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
  - 2. A member company of NETA.
  - 3. Acceptable to authorities having jurisdiction

### **PART 2 - PRODUCTS**

#### 2.01 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
  - 1. Operation Technology, Inc. (ETAP)
  - 2. SKM Systems Analysis, Inc. (Power Tools)

#### 2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399, IEEE 1584 and NFPA 70E.
- B. Analytical features of fault-current-study, device coordination study and arc flash study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
  - 1. Optional Features:
    - i. Arcing faults.
    - ii. Simultaneous faults.
    - iii. Explicit negative sequence.



- iv. Mutual coupling in zero sequence.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
  - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.
- B. Provide a complete investigation of the existing power system as required for arc flash, faults, and coordination information. Investigate for any existing series rated equipment that is to remain and include coordination study to comply with codes. Include required field visits, trained personnel, and coordination with client to review switches, switchgear, conductors, head-end utility capacity, etc. Scope shall include coordination study of generator and solar voltaic feeds along with utility service.

### **3.02 POWER SYSTEM DATA**

- A. Gather and tabulate the following input data to support coordination study:
  - 1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  - 2. Impedance of utility service entrance.
  - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
    - i. Circuit-breaker and fuse-current ratings and types.
    - ii. Relays and associated power and current transformer ratings and ratios.
    - iii. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    - iv. Generator kilovolt amperes, size, voltage, and source impedance.
    - v. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    - vi. Busway ampacity and impedance.
    - vii. Motor horsepower and code letter designation according to NEMA MG 1.
  - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
    - i. Special load considerations, including starting inrush currents and frequent starting and stopping.
    - ii. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    - iii. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    - iv. Generator thermal-damage curve.
    - v. Ratings, types, and settings of utility company's overcurrent protective devices.

- vi. Special overcurrent protective device settings or types stipulated by utility company.
- vii. Time-current-characteristic curves of devices indicated to be coordinated.
- viii. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- ix. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- x. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

### 3.03 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
  - 1. Switchgear and switchboard bus.
  - 2. Medium-voltage controller.
  - 3. Distribution panelboard.
  - 4. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current according to IEEE 551.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
  - 1. Transformers:
    - i. ANSI C57.12.10.
    - ii. ANSI C57.12.22.
    - iii. ANSI C57.12.40.
    - iv. IEEE C57.12.00.
    - v. IEEE C57.96.
  - 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
  - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
  - 4. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
  - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
  - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
  - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

### 3.04 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
  1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
  2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
  3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 241; IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
  1. Device shall not operate in response to the following:
    - i. Inrush current when first energized.
    - ii. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - iii. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
  1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
    - i. Device tag.
    - ii. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
    - iii. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
    - iv. Fuse-current rating and type.
    - v. Ground-fault relay-pickup and time-delay settings.
  2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
    - i. Device tag.

- ii. Voltage and current ratio for curves.
- iii. Three-phase and single-phase damage points for each transformer.
- iv. No damage, melting, and clearing curves for fuses.
- v. Cable damage curves.
- vi. Transformer inrush points.
- vii. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

### 3.05 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.
  - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573. "Short-Circuit Studies."
  - 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573. "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
  - 1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
  - 2. Calculate arc-flash energy at the recommended short circuit values according to IEEE 1584.section 4.5.
  - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
  - 4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium-and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
  - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
  - 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
  - 1. When the circuit breaker is in a separate enclosure.
  - 2. When the line terminals of the circuit breaker are separate from the work location.

- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section 6.9.

### 3.06 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
  1. Protective device designations and ampere ratings.
  2. Conductor types, sizes, and lengths.
  3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
  4. Motor and generator designations and kVA ratings.
  5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
  1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
    - i. Voltage.
    - ii. Calculated symmetrical fault-current magnitude and angle.
    - iii. Fault-point X/R ratio.
    - iv. No AC Decrement (NACD) ratio.
    - v. Equivalent impedance.
    - vi. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    - vii. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
  1. Arcing fault magnitude.
  2. Protective device clearing time.
  3. Duration of arc.
  4. Arc-flash boundary.
  5. Restricted approach boundary.
  6. Limited approach boundary.
  7. Working distance.
  8. Incident energy.
  9. Hazard risk category.

10. Recommendations for arc-flash energy reduction.

- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

3.07 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch (76-by-127-mm) self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
  1. Location designation.
  2. Nominal voltage.
  3. Protection boundaries.
    - i. Arc-flash boundary.
    - ii. Restricted approach boundary.
    - iii. Limited approach boundary.
  4. Arc flash PPE category.
  5. Required minimum arc rating of PPE in Cal/cm squared.
  6. Available incident energy.
  7. Working distance.
  8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.
- D. Apply a label to each piece of equipment addresses by the study.

**END OF SECTION**

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## SECTION 26 08 01

### COMMISSIONING OF ELECTRICAL SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 INTRODUCTION

- A. The Owner directly contracts a commissioning agent for this project. This specification details the roles and responsibilities of each project team member as they apply to commissioning. Each contractor should review this procedure and include adequate time in their proposal.

##### 1.02 RELATED DOCUMENTS

- A. Contract drawings and specifications, general provisions of the contract, including general and supplementary conditions, electrical provisions and Division-1 Specification sections apply to work of this section.

##### 1.03 DESCRIPTION OF WORK

- A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Design Intent Documents (DID). The CxA shall provide the owner with an unbiased, objective view of the system's design, installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CxA will be a member of both the design and construction team. During the design phase, the CxA will assist the owner in development of the Owner's Project Requirements, review the Basis of Design, and develop project-specific commissioning specifications. During the construction phase, the CxA will administer and coordinate commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers which will include commissioning coordination meetings, equipment installation inspections, functional performance testing, issues resolution, and documentation of all aforementioned tasks and activities.

##### 1.04 REFERENCES

- A. Specification Section 01 91 13 - General Commissioning Requirements
- B. Specification Section 23 08 01 - Commissioning of Mechanical Systems
- C. ASHRAE Guideline 0 - 2019
- D. ASHRAE Guideline 1-2007

#### **PART 2 – PRODUCTS (Not applicable)**

#### **PART 3 - EXECUTION**

##### 3.01 ROLES AND RESPONSIBILITIES OF THE COMMISSIONING AGENCY

- A. Mission: The primary point of responsibility is to inform the general contractor, the owner and design team on the status, integration, and performance of mechanical and electrical systems within the facility.
- B. Information: The CxA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction



process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owners O&M staff.

- C. Quality Assurance: Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.
- D. Observation of Tests: The CxA shall observe and coordinate testing as required to assure system performance meets the design intent.
- E. Documentation of Tests: The CxA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CxA shall compile standard forms to be used by the commissioning team for consistency of approach and type of information to be recorded.
- F. Deficiencies: The CxA shall provide technical expertise to facilitate and verify the correction of deficiencies found during the commissioning process.
- G. Resolution of Deficiencies: The CxA is to remain an independent party with specific technical knowledge of the project. The CxA shall investigate the scope and extent of problems and facilitate communication to determine responsibilities by delineating specifications. The CxA shall monitor resolution for conformance with design intent and prevailing industry standards.
- H. Acceptance: The CxA shall document the date of acceptance as determined by the General Contractor, owner and design team.
- I. Certificate(s) of Installation, Certificate(s) of Acceptance and Functional Performance Test results may be used in determining the start of the warranty period for HVAC and lighting systems and subsystems

### 3.02 ROLES AND RESPONSIBILITIES OF THE OWNER

- A. Assign facilities personnel and schedule them to participate in the various meetings, training sessions and inspections as follows:
  - 1. It is in the Owner's best interest to have facilities staff attend the following meetings:
    - a. Owners training session(s).
    - b. Contractors' commissioning kick-off meeting
      - 1) At the kickoff meeting, the Owner will indicate to GC whether facilities staff will attend any of the meetings detailed below.
  - 2. It is at the Owner's discretion to have facilities staff attend the following Cx meetings:
    - a. Equipment start-up events.
    - b. Lighting controls testing and acceptance
    - c. Emergency power system testing and acceptance
    - d. Functional performance testing of lighting control systems
    - e. Solar photovoltaic (PV) testing and acceptance

### 3.03 ROLES AND RESPONSIBILITIES OF THE DESIGN TEAM

- A. Provide Basis of Design Narrative.
- B. Verify adequate maintenance accessibility for each piece of equipment in shop drawings and actual installation. Visit site periodically and inspect construction.

### 3.04 ELECTRICAL SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

- A. Lighting and Associated Controls
- B. Emergency Power Systems including Generators, ATS's, Fuel Systems, UPS systems and all applicable supporting systems
- C. Solar (PV) Systems

### 3.05 ELECTRICAL COMMISSIONING PLAN

#### A. Commissioning Team

1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:
  - a. Program Manager/Owner (PrM)
  - b. Commissioning Agent (CxA)
  - c. Design Team (DT)
  - d. General Contractor (GC)
  - h. Electrical Contractor (EC)

#### B. Design Intent Document

1. The Design Intent Document (DID) represents a composite of design drawings, project specifications, submittals, change orders and industry standards, prepared by the designer of record, that describe the systems of this facility. References to design intent will be taken from the DID. The DID is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
2. The CxA will review the DID documents for commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

#### C. Commissioning Meetings

1. Commissioning meetings will be held in conjunction with progress meetings when possible and as necessary.
2. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

#### D. Resolution Tracking Forms (RTF)

1. The use of Resolution Tracking Forms is a method employed by the CxA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CxA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. Certificate(s) of Installation/ Manufacturer's Checklists

1. If requested, copies of the Certificate(s) of Installation shall be provided to the CxA within 7 days of request.
2. If requested, copies of the manufacturer's startup forms shall be provided to the CxA within 7 days of request.

F. Start-Up

1. The CxA will witness start-up of major systems when applicable. The systems to be witnessed will be identified and discussed during the Cx construction kickoff meeting. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up.
2. The installing contractor shall notify the CxA no later than 7 days prior to startup of equipment.

G. Functional Performance Tests (FPT)

1. The CxA will write FPT's based on the design intent document. These tests will be created for systems and subsystems.
2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CxA.
3. No FPT's will be performed until the system and related subsystems have been started, and the completion of the control system has been documented through point-to-point checklists and other documentation.
4. The Functional Performance Tests shall include lighting control and emergency power systems. The CxA will make every effort to not have contractors repeat work. However, some of the Functional Performance Tests may repeat the required Certificate(s) of Acceptance forms. For example, if multiple lighting control panels are installed, the CxA will review all of the Acceptance forms and request the contractor responsible for completing the Certificate of Acceptance form repeat one or more unit's lighting control panel tests. Emergency power system testing will require the on-site support of the generator manufacturer, the EC shall ensure they are on-site and support the commissioning process. If load banks are required for testing, the EC shall provide this equipment.

H. Building Turn-Over / Owner Orientation / User Training

1. The CxA may review O&M manuals, to ensure specificity and completeness.
2. The CxA will review as-built drawings, to ensure specificity and completeness.
3. The installing contractor or manufacturer's representative will provide the training. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use.
4. The CxA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

I. Training of Owner's Operators

1. The Owner's facility staff shall be given comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of equipment.
2. The GC will be responsible for scheduling the training which shall start with classroom sessions followed by hands on training on each piece of equipment. Hands on training shall include start-up, operation in all modes possible, shut-down and any emergency procedures.

3. The manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall review safe and proper operating requirements and preventative maintenance.
4. Each classroom training session shall be followed by an inspection, explanation and demonstration of the equipment. The start-up and shut-down modes of operation shall be demonstrated.
6. The EC and LCC shall conduct the training session on the lighting controls system hardware and software.

### 3.06 RESPONSIBILITIES OF INSTALLING CONTRACTORS

#### A. General Contractor (GC)

1. GC and all other contractor requirements for commissioning are included in section 01 91 13 and 23 08 01. The GC shall ensure that the EC meets the requirements listed in 23 08 01 and the requirements listed in (B.) below.

#### B. Electrical Contractor (EC)

1. Include cost for commissioning requirements in the contract price.
2. Attend commissioning meetings scheduled by the CxA.
3. Prepare preliminary schedule for indoor lighting system inspections, emergency power generator systems O&M manual submission, training sessions, lighting controls testing, emergency power system testing, system verification, performance testing, and system completion for use by the CxA. Update schedule as appropriate throughout the construction period and provide updated schedule to the commissioning team.
4. Verify proper installation and performance of all electrical services provided.
5. Complete Title 24 Certificate(s) of Installation and manufacturer's pre-start checklists prior to scheduling startup/programming of lighting control equipment.
  - a. Retain Certificate(s) of Installation in a 3-ring binder in an organized fashion. Binder is to remain on the job site
  - b. Make Certificate(s) of Installation available for CxA review upon request.
  - c. Retain calibration records for equipment provided with manufacturer calibrated sensors in the Certificate(s) of Installation binder.
  - d. Correct labeling of all circuits with connected equipment.
6. Where applicable, complete the Certificate(s) of Acceptance per the contract documents.
  - a. Retain Certificate(s) of Acceptance in a 3-ring binder in an organized fashion. Binder is to remain on the job site
  - b. Provide copies of all Certificate(s) of Acceptance to the CxA.
  - c. Certificate(s) of Acceptance shall be conducted by companies who are certified as California Advanced Lighting Controls Training Program Acceptance Technician (CALCTP-AT) employer and only completed by those employees of said company who are certified to complete the respective acceptance test.
7. Monitor and respond to Resolution Tracking Forms distributed by the CxA in order to expedite corrective actions necessary to achieve design intent.
8. Participate in the Certificate(s) of Acceptance and Functional Performance Tests as required to achieve design intent.

9. Participate in O&M Training as required by project specifications.
10. Ensure participation of major equipment manufacturers and their representatives as applicable. The generator manufacturer shall be on-site for generator startup and testing.
11. Obtain O & M data on all equipment and assemble in binders using tabs as required.
12. Conduct a maintenance orientation and inspection with hands on training per the contract documents.

**END OF SECTION**

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## SECTION 26 09 13

### ELECTRICAL POWER MONITORING AND CONTROL

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes the following for monitoring and control of electrical power system:
  - 1. PC-based workstation(s) and software.
  - 2. Communication network and interface modules for RS-232, RS-485, Modbus TCP/IP, and IEEE 802.3 data transmission protocols.
- B. Related Sections:
  - 1. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.

##### 1.03 DEFINITIONS

- A. Ethernet: Local area network based on IEEE 802.3 standards.
- B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- C. HTML: Hypertext markup language.
- D. I/O: Input/output.
- E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.
- F. LAN: Local area network; sometimes plural as "LANs."
- G. LCD: Liquid crystal display.
- H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
- I. Modbus TCP/IP: An open protocol for exchange of process data.
- J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- K. PC: Personal computer; sometimes plural as "PCs."
- L. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
- N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
- O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- P. THD: Total harmonic distortion.

Q. UPS: Uninterruptible power supply; used both in singular and plural context.

R. WAN: Wide area network.

#### 1.04 ACTION SUBMITTALS

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

1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances.
4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
5. UPS sizing calculations for workstation.
6. Surge Suppressors: Data for each device used and where applied.

#### 1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports for client record.

B. Other Informational Submittals:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

#### 1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Operating and applications software documentation.
2. Software licenses.
3. Software service agreement.
4. PC connection and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware.
5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

B. Software and Firmware Operational Documentation:

1. Self-study guide describing the process for setting equipment's network address; setting Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
  2. Software operating and upgrade manuals.
  3. Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.
  4. Device address list and the set point of each device and operator option, as set in applications software.
  5. Graphic file and print out of graphic screens and related icons, with legend.
- C. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.
- D. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

#### 1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
  2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.
  3. I/O Protection Fuses: One for every 10 of each type installed. Furnish at least one of each type.

#### 1.08 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 1.09 COORDINATION

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

#### 1.10 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.



1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Schneider Electric - Power Management Operation (With ECC)
2. Generac
3. GE/ABB

### **2.02 FUNCTIONAL DESCRIPTION**

- A. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns where specified by Colton Electrical Utility.

1. Calculate and Record the Following:
  - i. Load factor.
  - ii. Peak demand periods.
  - iii. Metering to building BMS – include Modbus to BACnet converters

2. Measure and Record Metering Data for the Following:

- i. PV Electricity.
- ii. Generator (integrated) controls.

- B. Software: Calculate allocation of utility costs per Colton Electrical Utility.

1. Automatically Import Energy Usage Records to Allocate Energy Costs for PV production

- C. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters per Colton Electrical Utility and Generator manufacturer specifications:

1. Voltage regulation and unbalance.
2. Continuous three-phase rms voltage.
3. Periodic max./min./avg. voltage samples.
4. Harmonics.
5. Voltage excursions.

- D. Generator Load Shedding. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:

1. Determine system topology.
2. Evaluate remaining loads and sources.
3. Shed loads in less than 100 ms.
4. Mechanical system startup shall sequence upon generator

- E. Demand Management:

1. Peaking or co-generator control.

2. Load interlocking.
3. Load shedding.
4. Load trimming.

F. System: Report equipment status and power system control.

## 2.03 SYSTEM REQUIREMENTS

- A. Monitoring and Control System: Include multiple PC-based workstations with graphics capability and Web access, with its operating system and application software, connected to data transmission network.
- B. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
  1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
  2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
- C. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.
- D. DDC Interface: Provide factory-installed hardware and software to enable the DDC to monitor, display, and record data for use in processing reports.
  1. Both ASHRAE 135 (BACnet) and Modbus communication interfaces. Include DDC, system shall enable the DDC operator to remotely monitor meter information from a DDC operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the DDC BAS.
  2. Two protocol systems shall be involved: Modbus for generators and PV systems, and BACnet for building mechanical systems. Include hardware and programming to interface Modbus into the Building BACnet system

## 2.04 OPERATING SYSTEM

- A. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be Web enabled. Workstations and portable computers shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer. 100 Base-T Ethernet, Modbus TCP/IP RS-232, and RS-485 digital communications.
- B. Operating System Software: Software shall have the following features:
  1. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
  2. Graphical user interface to show pull-down menus and a menu tree format.
  3. Capability for future additions within the indicated system size limits.

## 2.05 APPLICATIONS SOFTWARE

- A. Basic Requirements:
  1. Fully compatible with and based on the approved operating system.
  2. Password-protected operator login and access; three levels, minimum.

3. Password-protected setup functions.
  4. Context-sensitive online help.
  5. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
  6. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
  7. Automatic and encrypted backups for database and history; automatically stored and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
  8. Operator audit trail for recording and reporting all changes made to user-defined system options.
- B. Workstation Server Functions:
1. Support other client PCs on the LAN.
  2. Maintain recorded data in databases accessible from other PCs on the LAN.
- C. Data Formats:
1. User-programmable export and import of data to and from commonly used spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
  2. Option to convert reports and graphics to HTML format.
  3. Interactive graphics.
  4. Option to send preprogrammed or operator designed e-mail reports.
- D. Metered Data: Display metered values in real time.
- E. Remote Control:
1. Display circuit-breaker/transfer switch status and allow breaker control.
  2. User defined with load-shedding automatically initiated and executed schemes responding to programmed time schedules, set points of metered demands, utility contracted load shedding, or combinations of these.
    - i. Generator loading shall require steps. Coordinate with mechanical controls contractor to step HVAC chiller and air handler loads in sequence indicated on plans
- F. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.
- G. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:
1. Site plan.
  2. Floor plans.
  3. Equipment elevations.
  4. Single-line diagrams.
- H. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:

1. Operator log on/off.
  2. Attempted operator log on/off.
  3. All alarms.
  4. Equipment operation counters.
  5. Out-of-limit, pickup, trip, and no-response events.
- I. Trending Reports: Display data acquired in real-time from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.
1. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
  2. Charting, statistical, and display functions of standard Windows-based spreadsheet.
- J. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.
1. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.
- K. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.
1. Tabular data shall be in the comma-separated values and as necessary to communicate with building BMS system
- L. Activity Billing Software:
1. Automatically compute and prepare activity demand and energy-use statements based on metering of energy use and peak demand integrated over user-defined interval.
  2. Intervals shall be same as used by electric utilities, including current vendor.
  3. Import metered data from saved records that were generated by metering and monitoring software.
  4. Maintain separate directory for each activity's historical billing information.
  5. Prepare summary reports in user-defined formats and time intervals.
- M. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
  2. Sort and report by device name and by function.
  3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
  4. Differentiate alarm signals from other indications.
  5. When system is reset, report reset event with same information concerning device, location, date, and time.
- N. Display Monitor:
1. Backlighted LCD to display metered data with touch-screen selecting device.

## 2.06 COMMUNICATION COMPONENTS AND NETWORKS

- A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP and BACnet.

## 2.07 POWER MONITORS

- A. Separately mounted, permanently installed instrument for power monitoring and control, complying with UL 1244. Components in conjunction with mechanical control systems at building
  - 1. Enclosure: NEMA 250, Type 1 interior units, 12 exterior units.
- B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - 1. Indoor installation in non-air-conditioned spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
- C. rms Real-Time Measurements by generator in coordination with PV metering:
  - 1. Current: Each phase, neutral, average of three phases, percent unbalance.
  - 2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
  - 3. Power: Per phase and three-phase total.
  - 4. Reactive Power: Per phase and three-phase total.
  - 5. Apparent Power: Per phase and three-phase total.
  - 6. Power Factor: Per phase and three-phase total.
- D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
  - 1. Present.
  - 2. Running average.
  - 3. Last completed interval.
  - 4. Peak.
- E. Demand Apparent Power Calculations, Three-Phase Total:
  - 1. Present.
  - 2. Running average.
  - 3. Last completed interval.
  - 4. Predicted.
  - 5. Peak.
  - 6. Coincident with peak kVA demand.
  - 7. Coincident with kVAR demand.
- F. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:
- G. Sampling:

1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
  2. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
- H. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
1. Line-to-line voltage.
  2. Line-to-neutral voltage.
  3. Current per phase.
  4. Line-to-line voltage unbalance.
  5. Line-to-neutral voltage unbalance.
  6. Power factor.
  7. Displacement power factor.
  8. Total power.
  9. Total reactive power.
  10. Total apparent power.
  11. Frequency.
- I. Current and Voltage Ratings:
1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
  2. Withstand ratings shall not be less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
  3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.
- J. Accuracy:
1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters. Accuracy from Light to Full Rating shall meet the following criteria:
    - i. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
    - ii. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
    - iii. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
    - iv. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
  2. For meters that are circuit-breaker accessories, metering accuracy at full-scale shall not be less than the following:
    - i. Current: Plus or minus 2.5 percent.
    - ii. Voltage: Plus or minus 1.5 percent.
    - iii. Energy, Demand, and Power: Plus or minus 4.0 percent.
    - iv. Frequency: Plus or minus 1 Hz.
- K. Input: One digital input signal(s).

1. Normal mode for on/off signal.
2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
3. Conditional energy signal to control conditional energy accumulation.

L. Onboard Data Logging:

1. Store logged data, alarms, events, and waveforms in 512 MB of onboard nonvolatile memory.
2. Stored Data:
  - i. Billing Log: User configurable where requested by Colton Electrical.
  - ii. Custom Data Logs: One user-defined log(s) holding up to 96
  - iii. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

M. Alarms.

1. User Options:
  - i. Define pickup, dropout, and delay.
  - ii. Assign one of four severity levels to make it easier for user to respond to the most important events first.
  - iii. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.
2. Alarm Events:
  - i. Over/undercurrent.
  - ii. Over/undervoltage.
  - iii. Current imbalance.
  - iv. Phase loss, current.
  - v. Phase loss, voltage.
  - vi. Voltage imbalance.
  - vii. Over kW demand.
  - viii. Phase reversal.
  - ix. Digital input off/on.
  - x. End of incremental energy interval.
  - xi. End of demand interval.

N. Control Power: 90- to 457-V ac or 100- to 300-V dc.

O. Communications:

1. Power monitor shall be permanently connected to communicate via RS-485 Modbus TCP/IP.
2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

P. Display Monitor:

1. Backlighted LCD to display metered data with touch-screen selecting device.
2. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
  - i. Current, per phase rms, three-phase average and neutral.
  - ii. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
  - iii. Real power, per phase and three-phase total.
  - iv. Reactive power, per phase and three-phase total.
  - v. Apparent power, per phase and three-phase total.
  - vi. Power factor, per phase and three-phase total.
  - vii. Frequency.
  - viii. Demand current, per phase and three-phase average.
  - ix. Demand real power, three-phase total.
  - x. Demand apparent power, three-phase total.
  - xi. Accumulated energy (MWh and MVARh).
3. Reset: Allow reset of the following parameters at the display:
  - i. Peak demand current.
  - ii. Peak demand power (kW) and peak demand apparent power (kVA).
  - iii. Energy (MWh) and reactive energy (MVARh).

## 2.08 RS-232 ASCII INTERFACE

- A. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels and alarm transmitters.
- B. Alarm System Interface:
  1. RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
- C. Cables:
  1. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - i. NFPA 70, Type CM.
    - ii. Flame Resistance: UL 1581, Vertical Tray.
  2. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - i. NFPA 70, Type CMP.
    - ii. Flame Resistance: NFPA 262, Flame Test.

## 2.09 LAN CABLES

- A. Comply with Section 271500 "Communications Horizontal Cabling."



B. RS-485 Cable:

1. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG (minimum, provide larger where indicated on plans), stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
2. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG (minimum, provide larger where indicated on plans), stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.

C. Unshielded Twisted Pair Cables: Category 5e and 6; OSP at underground and exterior applications.

2.10 LOW-VOLTAGE WIRING

A. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

**PART 3 - EXECUTION**

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

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

3.02 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Section 271500 "Communications Horizontal Cabling."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.

E. Install cables without damaging conductors, shield, or jacket.

3.03 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

B. Label each power monitoring and control module with a unique designation.

3.04 GROUNDING

A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

### 3.05 FIELD QUALITY CONTROL

- A. Provide simultaneous in-field coordination with service representatives for generator controls, PV system, Colton Electrical Utility, Switchboard Manufacturer Energy Control Systems, and Mechanical Building Management System vendor for complete controls.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Electrical Tests: Use caution when testing devices containing solid-state components.
  - 2. Continuity tests of circuits.
  - 3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.
    - i. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
    - ii. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
    - iii. Verify accuracy of graphic screens and icons.
    - iv. Metering Test: Load feeders, measure loads on feeder conductor with a rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
    - v. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.
- D. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Correct deficiencies make necessary adjustments, and retest. Verify that specified requirements are met.
- G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- I. Remove and replace malfunctioning devices and circuits and retest as specified above.

### 3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. See Section 017900 "Demonstration and Training."

1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 16 hours' training: 4 sessions, four hours each, on different days.
2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

3.07 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose. Include necessary field meetings with service representatives for generator controls, PV system, Colton Electrical Utility, Switchboard Manufacturer Energy Control Systems, and Mechanical Building Management System vendor.

**END OF SECTION**

## SECTION 26 09 44

### INTERIOR NETWORK LIGHTING CONTROL - NLIGHT

#### PART 1 - GENERAL

##### 1.01 SUMMARY

A. Section includes a networked lighting control system comprised of the following components

1. System Software Interfaces
  - i. Management Interface
  - ii. Historical Database and Analytics Interface
  - iii. Visualization Interface
  - iv. Personal Control Applications
  - v. Smartphone Programming Interface for wired devices
2. System Backbone and Integration Equipment
  - i. System Controller
  - ii. OpenADR Interface
3. Wired Networked Devices
  - i. Wall Switches, Dimmers and Scene Controllers
  - ii. Graphic Wallstations
  - iii. Auxiliary Input/Output Devices
  - iv. Occupancy and Photocell Sensors
  - v. Wall Switch Sensors
  - vi. Embedded Sensors
  - vii. Power Packs and Secondary Packs
  - viii. Networked Luminaires
  - ix. Relay and Dimming Panel
  - x. Bluetooth® Low Energy Programming Device
  - xi. Communication Bridge
4. The networked lighting control system shall meet all of the characteristics and performance requirements specified herein.
5. The contractor shall provide, install and verify proper operation of all equipment necessary for proper operation of the system as specified herein and as shown on applicable drawings.

##### 1.02 RELATED DOCUMENTS

- A. Section 26 27 26 Wiring Devices
- B. Section 26 51 00 Interior Lighting Fixtures

##### 1.03 SUBMITTALS

- A. Submittal shall be provided including the following items.
  1. Bill of Materials necessary to install the networked lighting control system.

2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
3. Riser Diagrams showing device wiring connections of system backbone and floor plans pertinent to the specific project. Engineers design drawings returned back to the Engineer for review are not acceptable.
  - i. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems. The list shall include a checklist with all required information needed from the IT and required dates.
  - ii. Diagrams and Operational Descriptions to indicate system operation or interaction with other system(s).
  - iii. Contractor Startup/Commissioning Worksheet (must be completed prior to factory startup).
  - iv. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.
  - v. Hardware and Software Operation Manuals.

#### 1.04 APPROVALS

- A. Prior approval from owner's representative is required for products or systems manufactured by companies not specified in the Network Lighting Controls section of this specification.
- B. Any alternate product or system that has not received prior approval from the owner's representative at least 10 days prior to submission of a proposal package shall be rejected.
- C. Alternate products or systems require submission of catalog datasheets, system overview documents and installation manuals to owner's representative. The submittal shall include significant differences between the specified product and the alternate.

#### 1.05 QUALITY ASSURANCE

- A. Product Qualifications
  1. System electrical components shall be listed or recognized by a nationally recognized testing laboratory (e.g., UL, ETL, or CSA) and shall be labeled with required markings as applicable.
  2. System luminaires and controls shall be designed and manufactured for interoperability.
  3. All components shall be subjected to 100% end of line testing prior to shipment to the project site to ensure proper device operation.
  4. All components and the manufacturing facility where product was manufactured must be RoHS compliant.
- B. Installation and Startup Qualifications
  1. System start-up shall be performed by qualified personnel approved or certified by the manufacturer.
- C. Service and Support Requirements
  1. Phone Support: Toll free technical support shall be available.
  2. Remote Support: The bidder shall offer a remote support capability.
  3. Onsite Support: The bidder shall offer onsite support that is billable at whole day rates.
  4. Service Contract: The bidder shall offer a Service Contract that packages phone, remote, and onsite support calls for the project. Response times for each type of

support call shall be indicated in the terms of the service contract included in the bid package.

1.06 PROJECT CONDITIONS

- A. Only install equipment after the following site conditions are maintained:
- B. Ambient Temperature: 14 to 105°F.
- C. Relative Humidity: less than 90% non-condensing
- D. Equipment shall not be subjected to dust, debris, moisture, or temperature and humidity conditions exceeding the requirements indicated above, at any point prior to installation.
- E. Only properly rated equipment and enclosures, installed per the manufacturer's instructions, may be subjected to dust and moisture following installation.

1.07 WARRANTY

- A. The manufacturer shall provide a minimum five-year warranty on all hardware devices supplied and installed. Warranty coverage shall begin on the date of shipment.
- B. The hardware warranty shall cover repair or replacement, including programming, any defective products within the warranty period.

1.08 MAINTENANCE & SUSTAINABILITY

- A. The manufacturer shall make available to the owner new parts, upgrades, and/or replacements available for a minimum of 5 years following installation.

**PART 2 - EQUIPMENT**

- A. Basis of Design System: Acuity Controls nLight

2.02 SYSTEM COMPLIANCE

- A. System components shall comply with UL 916 and UL 924 standards where applicable.
- B. System components shall comply with CFR Title 47, Part 15 standards where applicable.
- C. All equipment shall be installed and connected in compliance with NFPA 70.

2.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. System Architecture
  - 1. System shall have an architecture that is based upon three main concepts: (1) networkable intelligent lighting control devices, (2) standalone lighting control zones using distributed intelligence, (3) optional system backbone for remote, time based and global operation between control zones.
  - 2. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 10V input, and manual wallstation capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.
  - 3. System must be capable of interfacing directly with networked luminaires such that either low voltage network cabling communication is used to interconnect networked luminaires with control components such as sensors, switches and system backbone (see Control Zone Characteristics sections for each type of network connection, wired).

4. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wallstations without requiring connection to a higher level system backbone; this capability is referred to as “distributed intelligence.”
  - i. Lighting control zones (wired) of at least 128 devices per zone shall be supported.
5. The system shall be capable of providing individually addressable switching and dimming control of the following: networked luminaires, control zones, and relay and dimming outputs from centralized panels to provide design flexibility appropriate with sequence of operations required in each project area or typical space type.
6. Networked luminaires and intelligent lighting control devices shall support individual (unique) configuration of device settings and properties.
7. Networked luminaires and intelligent lighting control devices shall have distributed intelligence programming stored in non-volatile memory such that following any loss of power the lighting control zones shall operate according to their defined default settings and sequence of operations.
8. Lighting control zones shall be capable of being networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software interface.
9. The system may include one or more system controllers that provide time-based control and global system control across multiple control zones and backbone network segments. The system controller also provides a means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP protocol.
10. The system may include “communication bridge” devices that route communication from lighting control zones (wired) to and from the system controller, for purposes of decreasing system wiring requirements.
11. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality at a later date.

**B. Wired Networked Control Zone Characteristics**

1. Connections to devices within a wired networked lighting control zone and to backbone components shall be with a single type of low voltage network cable, which shall be compliant with CAT5e specifications or higher. To prevent wiring errors and provide cost savings, the use of mixed types of low voltage network cables shall not be permitted.
2. Devices in an area shall be connected via a “daisy-chain” topology; requiring all individual networked devices to be connected back to a central component in a “hub-and-spoke” topology shall not be permitted, so as to reduce the total amount of network cable required for each control zone.
3. System shall provide the option of having pre-terminated plenum rated low voltage network cabling supplied with hardware so as to reduce the opportunity for improper wiring and communication errors during system installation.
4. Following proper installation and provision of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g., software application, handheld remote, pushbutton). The “out of box” default sequence of operation is intended to provide typical sequence

of operation so as to minimize the system start-up and programming requirements and to also have functional lighting control operation prior to system start-up and programming.

5. Once software is installed, system shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.
6. All networked devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/start-up personnel.
7. Networked control devices intended for control of egress and/or emergency light sources shall not require the use of additional, externally mounted UL924 shunting and/or 0-10V disconnect devices, so as to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:
  - i. Low-Voltage power sensing: These devices shall automatically provide 100% light level upon detection of loss of power sensed via the low voltage network cable connection.
  - ii. UL924-Listed Line-Voltage power sensing: These devices shall be listed as emergency relays under the UL924 standard and shall automatically close the load control relay(s) and provide 100% light output upon detection of loss of power sensed via line voltage connections.

#### C. System Integration Capabilities

1. The system shall interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols. The following system integration capabilities shall be available via BACnet/IP and BACnet/MSTP protocols:
  - i. The system shall support control of individual devices, including, but not limited to, control of relay and dimming output. All system devices shall be available for control.
  - ii. The system shall support reading of individual device status information, including but not limited to, relay state, dimming output, power measurement, occupancy sensor status, and photocell sensor states or readings. All system devices shall be available for polling for devices status.
  - iii. The system shall support activation of pre-defined system Global Profiles (see Supported Sequence of Operations for further definition of Global Profile capabilities).
  - iv. The system shall support activation of Profiles (local or global) and Preset Scenes from third party systems by receiving dry contact closure output signals or digital commands via RS-232/RS-485.
  - v. The system shall support activation of system profiles from Demand Response Automation Servers via the OpenADR 2.0a protocol.

#### D. Supported Sequence of Operations

1. The following characteristics and performance requirements shall apply to wired control zones provided by the system.
2. Control Zones
  - i. Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) shall be capable of transmitting and tracking occupancy sensor, photocell sensor, and manual switch



information within at least 48 unique control zones to support different and reconfigurable sequences of operation within the area. These shall also be referred to as local control zones.

- ii. Networked luminaires and intelligent lighting control devices located in different areas shall be able to transmit and track occupancy, photocell, and switch information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. These shall also be referred to as global control zones.

### 3. Wallstation Capabilities

- i. Wallstations shall be provided to support the following capabilities:
  - 1) On/Off of a local control zone and global control zone simultaneously, as required.
  - 2) Continuous dimming control of light level of a local control zone and global control zone simultaneously, as required.
  - 3) Preset Scenes that can activate a specific combination of light levels across multiple local and global channels, as required.
  - 4) Profile Scenes that can modify the sequence of operation for the devices in the area (group) in response to a button press. This capability is defined as supporting "Local Profiles" and is used to dynamically optimize the occupant experience and lighting energy usage. Parameters that shall be configurable and assigned to a Local Profile include light level, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response) and enabling/disabling of wallstations.
- ii. Dimming control to allow color tuning between 3000 and 5000K (Kelvin)
  - 1) 3-way / multi-way control: multiple wallstations shall be capable of controlling the same local and global control zones, so as to support "multi-way" switching, dimming, preset scene, and profile scene control.

### 4. Occupancy Sensing Capabilities

- i. Local and global control: Occupancy sensors shall be configurable to control a local and global zone simultaneously, as required.
- ii. Multi-sensor control: multiple occupancy sensors shall be capable of controlling the same local and global control zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zone addresses.
- iii. System shall support the following types of occupancy sensing sequence of operations:
  - 1) On/Off Occupancy Sensing
  - 2) Partial-On Occupancy Sensing
  - 3) Partial-Off Occupancy Sensing
  - 4) Vacancy Sensing (Manual-On / Automatic-Off)
- iv. On/Off, Partial-On, and Partial-Off Occupancy Sensing modes shall function according to the following sequence of operation:
  - 1) Occupancy sensors automatically turn lights on to a designated level when occupancy is detected. To support fine tuning of Partial-On

sequences the designated occupied light level shall support at least 100 dimming levels.

- 2) Occupancy sensors automatically turn lights off or to a dimmed state(Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels.
  - 3) To provide additional energy savings the system shall also be capable of combining Partial-Off and Full-Off operation by dimming the lights to a designated level when vacant and then turning the lights off completely after an additional amount of time.
  - 4) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under Photocell Sensing Capabilities.
  - 5) The use of a wallstation shall change the dimming level or turn lights off as selected by the occupant. The lights shall remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
- v. Vacancy Sensing mode (also referred to as Manual-On / Automatic-Off) shall function according to the following sequence of operation:
- 1) The use of a wallstation is required turn lights on. The system shall be capable of programming the zone to turn on to either to a designated light level or the previous light level. Initially occupying the space without using a wallstation shall not result in any change in light level.
  - 2) Occupancy sensors shall automatically turn lights off when vacancy occurs is detected. To provide an enhanced occupant experience the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.
  - 3) To minimize occupant impact in case the area or zone is still physically occupied following dimming or shutoff of the lights due to detection of vacancy, the system shall support an "automatic grace period" immediately following detection of vacancy, during which time any detected occupancy shall result in the lights reverting to the previous level. After the grace period has expired, the use of a wallstation is required to turn lights on.
  - 4) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under Photocell Sensing Capabilities.
  - 5) At any time, the use of a wallstation shall change the dimming level or turn lights off as selected by the occupant. The lights shall remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
- vi. To accommodate different types of environments, vacancy time delays before dimming or shutting off lights shall be specifiable for control zones between 15 seconds to 2 hours.

## 5. Photocell Sensing Capabilities (Automatic Daylight Sensing)

- i. Photocell sensing devices shall be configurable to control a local and global zone simultaneously, as required.
- ii. The system shall support the following types of photocell-based control:
  - 1) On/Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. A time delay or adaptive setpoint adjustable behavior may be used to prevent the system from exhibiting nuisance on/off switching.
  - 2) Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

## 6. Schedule and Global Profile Capabilities

- i. The system shall be capable of automatically modifying the sequence of operation for selected devices in response to any of the following: a time-of-day schedule, contact closure input state, RS-232/RS-485 command, BACnet input command, and demand response signal. This capability is defined as supporting "Global Profiles" and is used to dynamically optimize the occupant experience and lighting energy usage.
- ii. Scheduling. Global profiles may be scheduled with the following capabilities:
  - 1) Global Profiles shall be stored within and executed from the system controller (via internal timeclock) such that a dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
  - 2) Global Profile time of day schedules shall be capable of being given the following recurrence settings: daily, specific days of week, every "n" number of days, weekly, monthly, and yearly. Lighting control profile schedules shall support definition of start date, end date, end after "n" recurrences, or never ending. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
  - 3) Global Profiles shall be capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
  - 4) Blink warning and timed extension capabilities. At the end of a scheduled period, the system shall be capable of providing a visible "blink warning" 5 minutes prior to the end of the schedule. Wallstations may be programmed to provide timed overrides that turn the lights on for an additional period of time. Timed override duration shall be programmable for each individual device, zone of devices, or customized group of devices, ranging from 5 minutes to 12 hours.
  - 5) Software management interface shall be capable of displaying a graphic calendar view of profile schedules for each control zone.
- iii. System Global Profiles shall have the following additional capabilities:

- 1) Global Profiles shall be capable of being manually activated directly from the system controller, specially programmed input devices, and software management interface.
- 2) Global Profiles shall be selectable to apply to a single device, zone of devices, or customized group of devices.
- 3) Parameters that shall be configurable and assigned to a Global Profile include light level, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response) and enabling/disabling of wallstations.
- iv. A backup of Local and Global Profiles shall be stored on the software's host server such that the Profile backup can be applied to a replacement system controller or wallstation.
7. Automated demand response capabilities. Profiles created for automated demand response events shall support automatic reduction of light level to programmable values. At least four levels of demand response profiles shall be supported by the system.

## 2.04 SYSTEM SOFTWARE INTERFACES

### A. Management Interface

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. Management interface shall require all users to login with a User Name and Password and shall support creation of at least 100 unique user accounts.
4. Management interface shall support at least three permission levels for users: read-only, read & change settings, and full administrative system access.
5. Management interface shall be capable of restricting read-only and read & change access for user accounts to specific devices within the system.
6. All system devices shall be capable of being given user-defined names.
7. The following device identification information shall be displayed in the Management interface: model number, model description, serial number, manufacturing date code custom label(s), and parent network device.
8. Management interface shall be able to read the live status of a networked luminaire or intelligent control device and shall be capable of displaying luminaire on/off status, dim level, power measurement, device temperature, PIR occupancy sensor status, microphonic occupancy sensor status, remaining occupancy time delay, photocell reading, and active Scenes or Profiles.
9. Management interface shall be able to read the current active settings of a networked luminaire or intelligent control device and shall be capable of displaying dimming trim levels, occupancy sensor and photocell enable/disable, occupancy sensor time delay and light level settings, occupancy sensor response (normal or vacancy), and photocell setpoints and transition time delays.
10. Management interface shall be able to change the current active settings and also default settings for an individual networked luminaire or intelligent control device.

11. Management interface shall be capable of applying settings changes for a zone of devices or a group of selected devices using a single "save" action that does not require the user to save settings changes for each individual device.
12. A printable network inventory report shall be available via the management interface.
13. A printable report detailing all system profiles shall be available via the management interface.
14. All sensitive information stored by the software shall be encrypted.
15. All system software updates must be available for automatic download and installation via the Internet.

**B. Historical Database and Analytics Interface**

1. System shall provide a historical database that stores device operational history and calculates energy usage for all networked luminaires and intelligent control devices.
2. System shall be capable of reporting lighting system events and performance data back to the historical database for display and analysis.
3. Historical database shall be capable of recording historical data for up to 20,000 networked devices for a period of at least 1 calendar year.
4. An "Energy Scorecard" shall be displayed that shows calculated energy savings in dollars, kWh, or CO<sub>2</sub>.
5. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc.).
6. Energy savings data shall be calculated for the system as a whole or for individual zones.
7. A time scaled graph showing all relay transitions shall be presented.
8. A time scaled graph showing a zones occupancy time delay shall be presented
9. A time scaled graph showing the total light level shall be presented.
10. User shall be able to customize the baseline run-time hours for a space.
11. User shall be able to customize up to four time-of-day billing rates and schedules.
12. Historical data shall be exportable from the Historical Database via a "CSV" type of file format.

**C. Visualization Interfaces**

1. System shall provide a web-based visualization interface that displays graphical floorplan.
2. Graphical floorplan shall offer the following types of system visualization:
  - i. Full Device Option - A master graphic of the entire building, by floor, showing each control device installed in the project with zones outlined to include but not be limited to the following:
    - 1) Controls embedded light fixtures
    - 2) Controls devices not embedded in light fixtures
    - 3) Daylight Sensors
    - 4) Occupancy Sensors
    - 5) Wall Switches and Dimmers
    - 6) Scene Controllers

- 7) Networked Relays
- 8) Bridges
- 9) System Controllers
- 10) Panels
- 11) Zone outlines
- ii. Zone Only Option - A master graphic of the entire building, by floor, showing control zones:
  - 1) Zones outlined
- iii. Allow for pan and zoom commands so smaller areas can be displayed on a larger scale simply by panning and zooming each floor's master graphic.
- iv. A mouse click on any control device shall display the following information (as applicable):
  - 1) The device catalog number.
  - 2) The device name and custom label.
  - 3) Device diagnostic information.
  - 4) Information about the device status or current configuration is available with an additional mouse click.

#### D. Personal Control Applications

1. Software interface shall support personal control software applications that provide user- specific control of individual luminaires, control zones, and scene presets.
2. Personal control applications shall support control of dimming output or definition of dimming presets for luminaires and devices that are dimmable.
3. The system administrator shall be capable of defining personal control permissions for each user account.
4. Software interface shall provide a Microsoft Windows® operating system taskbar application for personal lighting control.
5. Software interface shall provide an Apple iOS® operating system application (supported by mobile phones and mobile tablet devices) for personal lighting control.

#### E. Smartphone Programming Interface for Wired Devices

1. Application interface shall be provided for both Apple iOS® and Android operating systems that allows configuration of lighting control settings.
2. The application shall support the configuration of wired networked control devices via a Bluetooth® Low Energy (BLE) Programming Device.
  - i. Application shall support a security pin-code to access the zone of lighting control devices.
  - ii. The application shall provide indication of signal strength where multiple Bluetooth Low Energy Programming Devices are available for configuration.
  - iii. The application shall indicate the number of wired networked control devices.
3. Programming capabilities through the application shall include, but not be limited to, the following:
  - i. Switch/occupancy/photosensor group configuration

- ii. Manual/automatic on modes
- iii. Turn-on dim level
- iv. Occupancy sensor time delays
- v. Dual technology occupancy sensors sensitivity
- vi. Trim level settings

## 2.05 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

### A. IP nLight ECLYPSE™ System Controller (IP-NE-CTRL)

1. System Controller shall be multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. System Controller shall have 32-bit microprocessor operating at a minimum of 1 GHz.
3. System Controller shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases.
4. System Controller shall perform the following functions:
  - i. Facilitation of global network communication between different areas and control zones.
  - ii. Time-based control of downstream wired network devices.
  - iii. Linking into an Ethernet network.
  - iv. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
  - v. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
5. System Controller shall have an integral web server to support configuration, diagnostics and hosting of software interfaces.
6. Device shall have option for a graphical touch screen to support configuration and diagnostics.
7. Device shall have three RJ-45 networked lighting control ports for connection to any of the following:
  - i. The graphical touch screen
  - ii. Wired communication bridges
  - iii. Direct connection to networked wired luminaires and intelligent lighting control devices (up to 128 total devices per port)
8. Device shall be capable of communicating with network bridges and software interfaces via LAN connection.
9. Device shall automatically detect all networked devices connected to it, including those connected to wired communication bridges.
10. Device shall have a standard internal time clock.
11. Device shall have 2 switched RJ-45 10/100 BaseT Ethernet ports for local area network (LAN) connection

- i. Ethernet connection shall support daisy chain wiring to other lighting control system LAN devices, such as other system controllers networked communication bridges.
  - ii. Ethernet connection shall support IPv4 and shall be capable of using a dedicated static or DHCP assigned IP address.
- 12. Device shall have 2 x USB 2.0 Expansion ports for
- 13. Each System Controller shall be capable of managing and operating at least 1500 networked devices (wired).
  - i. Multiple System Controllers may be networked together via LAN connection to scale the system up to 20,000 networked devices.
- 14. System Controller shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
  - i. BACnet/MSTP shall support up to minimum of 50 additional BACnet MS/TP controllers in addition to the Expansion I/O modules.
  - ii. BACnet/MSTP shall support 9600 to 115200 baud.
  - iii. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
  - iv. Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module.
- B. OpenADR Interface
  - 1. System shall provide an interface to OpenADR protocol Demand Response Automation Servers (DRAS) typically provided by local electrical utility.
  - 2. OpenADR interface shall meet all of the requirements of Open ADR 2.0a Virtual End Nodes(VEN), including:
    - i. Programmable with the account information of the end-user's electrical utility DRAS account credentials.
  - 3. OpenADR interface shall support the activation of system profiles configured for each of the automated demand response levels defined in the utility demand response program.

## 2.06 WIRED NETWORKED DEVICES

- A. Wired Networked Wall Switches, Dimmers, Scene Controllers
  - 1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
  - 2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
  - 3. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
  - 4. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
  - 5. Devices with mechanical push-buttons shall be made available with custom button labeling.
  - 6. Wall switches & dimmers shall support the following device options:
    - i. Number of control zones: 1, 2 or 4
    - ii. Control Types Supported: On/Off or On/Off/Dimming



iii. Colors: Ivory, White, Light Almond, Gray, Black, Red

7. Scene controllers shall support the following device options:

- i. Number of scenes: 1, 2 or 4
- ii. Control Types Supported:
  - 1) On/Off
  - 2) On/Off/Dimming
  - 3) Preset Level Scene Type
  - 4) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene
  - 5) Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones
  - 6) Colors: Ivory, White, Light Almond, Gray, Black, Red
  - 7) Color tuning dimming to allow between 3000 and 5000K (Kelvin)

B. Wired Networked Graphic Wallstations

1. Device shall surface mount to single-gang switch box.
2. Device shall have a 3.5" full color touch screen.
3. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
4. Device shall have a micro-USB style connector for local computer connectivity.
5. Communication shall be over standard low voltage network cabling with RJ-45 connectors.
6. Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.
7. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
8. Graphic wallstations shall support the following device options:
  - i. Number of control zones: Up to 16
  - ii. Number of scenes: Up to 16
  - iii. Colors: Ivory, White, Light Almond, Gray, Black

C. Wired Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½ in knockout.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:
  - i. Contact closure input
    - 1) Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, ramp light level up or down, or toggle lights on/off.
  - ii. 0-10V analog input

- 1) Input shall be programmable to function as a daylight sensor.
- iii. RS-232/RS-485 digital input
  - 1) Input supports activation of local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
- iv. 0-10V dimming control output, capable of sinking up to 20mA of current
  - 1) Output shall be programmable to support all standard sequence of operations supported by system.

D. Wired Networked Occupancy and Photosensors

1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR / Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR / Ultrasonic) shall not be acceptable.
5. All sensing technologies shall be acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared(PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
6. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
7. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
8. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
9. Network system shall have ceiling, fixture, recessed & corner mounted sensors available, with multiple lens options available customized for specific applications.
10. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
11. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.
12. Sensors shall have optional features for photosensor/daylight override, dimming control, and low temperature/high humidity operation.
13. Photosensor shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
14. Photosensor and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point

Programming” procedure. Min and max dim settings as well as set-point may be manually entered.

15. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
16. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an “offset” from the primary zone.

#### E. Wired Networked Wall Switch Sensors

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. All wall switch sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices with mechanical push-buttons shall provide tactile user feedback.
5. Wall switches sensors shall support the following device options:
  - i. User Input Control Types Supported: On/Off or On/Off/Dimming
  - ii. Occupancy Sensing Technology: PIR only or Dual Tech acoustic
  - iii. Daylight Sensing Option: Inhibit Photosensor
  - iv. Colors: Ivory, White, Light Almond, Gray

#### F. Wired Networked Embedded Sensors

1. Network system shall have embedded sensors consisting of occupancy sensors and/or dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
2. Occupancy sensor detection pattern shall be suitable for 7.5 ft. to 20 ft. mounting heights.
3. Embedded sensors shall support the following device options:
  - i. Occupancy Sensing technology: PIR only or Dual Tech acoustic
  - ii. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor

#### G. Wired Networked Power Packs and Secondary Packs

1. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC) and carry a plenum rating.
3. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output but shall not be required to contribute system power.
4. Power Supplies shall provide system power only but are not required to switch line voltage circuit.
5. Auxiliary Relay Packs shall switch low voltage circuits only, capable of switching 1 amp at 40 VAC/VDC (resistive only).

6. Communication shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors. Secondary packs shall receive low voltage power via standard low voltage network cable.
7. Power Pack programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
8. Power Pack shall securely mount to junction location through a threaded ½ in chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
9. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
10. Power/Secondary Packs shall be available with the following options:
11. Power Pack capable of full 16-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
12. Secondary Pack with UL924 listing for switching of full 16-Amp Emergency Power circuits, with optional 0-10V dimming output capable of up to 100mA of sink current.
13. Power and Secondary Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
14. Secondary Pack capable of full 16-Amp switching of all normal power lighting load types.
15. Secondary Pack capable of 5-Amps switching and dimming 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
16. Secondary Pack capable of 5-Amps switching and dimming of 120/277 VAC magnetic low voltage transformers.
17. Secondary Pack capable of 4-Amps switching and dimming of 120 VAC electronic low voltage transformers.
18. Secondary Pack capable of louver/damper motor control for skylights.
19. Secondary Pack capable of providing a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
20. Secondary Pack capable of switching 1 amp at 40 VAC/VDC (resistive only) with the intent to provide relay signal to auxiliary system (e.g. BMS).
21. Power Supply capable of providing auxiliary bus power (no switched or dimmed load).

#### H. Wired Networked Relay and Dimming Panel

1. Relay and dimming panel shall be available with 4, 8, 12 or 16 individual Field Configurable Relays (FCR) per panel, with an equal number of individual 0-10V dimming outputs.
2. Standard relays used shall have the following required properties:
  - i. Configurable in the field to operate with single-, double-, or triple-pole relay groupings.

- ii. Configurable in the field to operate with normally closed or normally open behavior.
- iii. Provides visual status of current state and manual override control of each relay.
- iv. Listed for the following minimum ratings:
  - 1) 40A@120-480VAC Ballast
  - 2) 16A@120-277VAC Electronic
  - 3) 20A@120-277VAC Tungsten
  - 4) 20A@48VDC Resistive
  - 5) 2HP @ 120VAC,
  - 6) 3HP @ 240-277VAC
  - 7) 65kA SCCR @ 480VAC
- 3. 0-10 dimming outputs shall support a minimum of 100mA sink current per output.
- 4. Relay and dimming outputs shall be individually programmable to support all standard sequence of operations as defined in this specification.
- 5. Panel shall be UL924 listed for control of emergency lighting circuits.
- 6. Panel shall power itself from an integrated 120-277VAC or 347VAC supply.
- 7. Panel shall provide a configurable low-voltage sensor input with the following properties:
- 8. Configurable to support any of the following input types:
  - i. Indoor Photocell
  - ii. Outdoor Photocell
  - iii. Occupancy Sensor
  - iv. Contact Closure
    - 1) Low voltage sensor input shall provide +24VDC power for the sensor so that additional auxiliary power supplies are not required.
    - 2) Sensor input supports all standard sequence of operations as defined in this specification.
- 9. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays (i.e., normally open or normally closed) in the panel. This input is intended to provide an interface to alarm systems, fire panels, or BMS system to override the panel.
- 10. Panel shall supply current limited low voltage power to other networked devices connected via low voltage network cable.
- 11. Panel shall be available with NEMA 1 rated enclosure with the following properties:
  - i. Surface-mounted or flush-mounted enclosure back box
  - ii. Screw-fastened cover or hinged cover with keyed lock
- 12. Panel shall be rated from 32-122 °F.
- I. Wired Networked Bluetooth® Low Energy Programming Device
  - 1. Device shall be plenum rated and be inline wired, screw mountable.

2. Communication and low voltage power shall be delivered to device via standard low voltage network cabling with RJ-45 connectors.
  3. Bluetooth Low Energy connection shall allow connection from smartphone application for programming device settings within the local daisy-chain zone (see list of available settings in section, 2.4-System Software Interfaces, Sub-section .5).
    - i. Device shall provide visual indication of remote Bluetooth connection via LED integrated into device enclosure such that it is visible from all angles while the zone is being programmed.
- J. Wired Networked Communication Bridge
1. Device shall surface mount to a standard 4" x 4" square junction box.
  2. Device shall have 8 RJ-45 ports for connection to lighting control zones (up to 128 devices per port), additional network bridges, and System Controller.
  3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to System Controller.
  4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or powered via low voltage network connections from powered lighting control devices (e.g. power packs).
  5. Wired Bridge shall be capable of redistributing power from its local supply and connected lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION REQUIREMENTS**

#### **A. Installation Procedures and Verification**

1. The successful bidder shall review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.
2. The successful bidder shall install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.
3. The successful bidder shall be responsible for testing of all lighting control low voltage network cable included in the bid. Bidder is responsible for verification of the following minimum parameters:
  - i. Wire Map (continuity, pin termination, shorts and open connections, etc.)
  - ii. Length
  - iii. Insertion Loss

#### **B. Coordination with Owner's IT Network Infrastructure**

1. The successful bidder is required to coordinate with the owner's representative to secure all required network connections to the owner's IT network infrastructure.
  - i. The bidder shall provide to the owner's representative all network infrastructure requirements of the networked lighting control system.

- ii. The bidder shall provide to the manufacturer's representative all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.

C. Documentation and Deliverables

1. The installing contractor shall be responsible for documenting installed location of all networked devices, including networked luminaires. This includes responsibility to provide as-built plan drawing showing device address barcodes corresponding to locations of installed equipment.
2. The installing contractor is also responsible for the following additional documentation to the manufacturer's representative if visualization / graphical floorplan software is provided as part of bid package:
  - i. As-Built floor plan drawings showing daisy-chain wired network control zones outlined, in addition to device address locations required above. All documentation shall remain legible when reproducing/scanning drawing files for electronic submission.
  - ii. As-Built electrical lighting drawings (reflected ceiling plan) in PDF and CAD format. Architectural floor plans shall be based on as-built conditions.
    - 1) CAD files shall have layers already turned on/off as desired to be shown in the graphical floorplan background images. The following CAD elements are recommended to be hidden to produce an ideal background graphical image:
      - a) Titleblock
      - b) Text- Inclusive of room names and numbers, fixture tags and drawings notes
      - c) Fixture wiring and homeruns
      - d) Control devices
      - e) Hatching or poché of light fixtures or architectural elements
    - 2) CAD files shall be of AutoCAD 2013 or earlier. Autodesk Revit files overall floor plan views shall be exported to AutoCAD 2013.

3.02 SYSTEM STARTUP

- A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed by an authorized representative of the manufacturer.
1. Low voltage network cable testing shall be performed prior to system startup.
- B. System start-up and programming shall include:
1. Verifying operational communication to all system devices.
  2. Programming the network devices into functional control zones to meet the required sequence of operation.
  3. Programming and verifying all sequence of operations.
  4. Customization of owner's software interfaces and applications.
- C. Initial start-up and programming is to occur on-site. Additional programming may occur on-site or remotely over the Internet as necessary.

3.03 PROJECT TURNOVER

- A. System Documentation and as-builts.

1. Submit software database file with desired device labels and notes completed.

**B. Owner Training**

1. Provisions for onsite training for owner and designated attendees to be included in submittal package. Training shall be a minimum of (1) day and shall be videotaped by the Contractor, and video provided to the Owner.
2. Contractor shall include in their bid a second training to occur (6) months after occupancy of building by the Owner. The second training shall be a minimum of (4) hours.

**END OF SECTION**

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## SECTION 26 22 00

### LOW-VOLTAGE TRANSFORMERS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - 1. Distribution transformers.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data including rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated. Include manufacturer's product data for each type of transformer and for each size specified. Highlight clearly specific information applicable to the project. Submittals with general catalogs will not be accepted and reviewed.
  - 1. K.V.A. and voltage of primary and secondary windings.
  - 2. Windings insulation class and rates temperature rise.
  - 3. Underwriters' Laboratories, Inc. (U.L.) label.
  - 4. Sound level test results of a similar transformer.
  - 5. Physical size and finish.
  - 6. Efficiency at 25, 50, 75 and 100 percent rated load.
  - 7. Windings material.
  - 8. Factory test report of ratio and polarity test.
  - 9. Factory test report of applied voltage test.
  - 10. Factory test report of induced voltage test.
  - 11. Factory test report of temperature rise at full load.
  - 12. Impedance rating and characteristics.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - i. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. If alternate manufacturer of products other than what are specified in this section are submitted, all necessary documents not limited to cut sheets, technical information, test reports from recognized testing labs and factory test reports shall be submitted to the satisfaction of the owner/engineer to ensure quality and conformance to the specifications. Additional testing shall be undertaken if it is concluded by the owner/engineer that the submitted test reports are either insufficient or do not include all tests necessary for product acceptance. The tests shall be conducted by a recognized lab acceptable to the owner/engineer and all tests shall be witnessed by owner's/engineer's personnel. All testing procedures and test results shall be satisfactory to the owner/engineer. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one owner's/engineer's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of low voltage transformers to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project
- E. Transformer shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g. transformer core, windings etc.) for the assembly.
- F. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., primary switch, transformer, and switchboard) shall be manufactured within six months of installation.
- G. Source Limitations: Obtain transformers through one source from a single manufacturer through a local distributor. All power distribution equipment shall be of the same manufacturer as the substation.
- H. Comply with NFPA 70.
- I. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- J. Electrical Components, Devices and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100 and marked for intended use.
- K. Testing Agency Qualifications:
  1. Testing agency shall be an independent company with the experience to conduct field testing as indicated; shall have been a member of Inter-National Testing Association (NETA) for a minimum of last ten (10) years.
  2. The company shall have permanent in-house testing engineers and technicians.
  3. Testing company shall be located within 50 miles radius of the project.
  4. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.

5. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of unit substations similar to the type and rating specified on this project.

L. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.08 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

**PART 2 - PRODUCTS**

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Square D; Schneider Electric.
  2. General Electric by ABB.

2.02 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: High grade, non-aging, grain-oriented, non-aging silicon steel. I with high magnetic permeability, and low hysteresis and eddy current losses. The core of the transformer shall be visibly grounded to the enclosure by means of flexible grounding conductor sized in accordance with applicable UL and NEC standard.
- C. Coils: Continuous windings without splices except for taps.
  1. Internal Coil Connections: Brazed or pressure type.
  2. Coil material: Copper. Basic Insulation Level (BIL) for all 600V class windings shall be 10KV.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2.
  1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Enclosure: Ventilated, NEMA 250, Type 3R.
  1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

2. Shall be fabricated of heavy gauge, sheet steel construction.
  3. All ventilated openings shall be protected against falling dirt.
  4. Ventilated, raintight, NEMA 250, Type 3R, stainless steel. Provide suitable weather shields over ventilation openings.
  5. Provide rodent screen on front opening of the transformer.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: ANSI 49 gray. The enclosure shall be finished utilizing a continuous process of degreasing, cleaning and phosphatizing followed by electrostatic deposition of polyester powder coating and baking.
- G. Taps for Transformers Smaller Than 3 kVA: None.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.
- K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Comply with DOE 10 CFR Part 431 Appendix A of Subpart K 2016.
  2. Energy efficiency under DOE 2016 requirements is to be Energy Verified by UL.
- L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor. K factor shall not exceed 4, 13 or 20. K factor shall be as listed on the drawings.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
  2. Indicate value of K-factor on transformer nameplate.
- M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  2. Include special terminal for grounding the shield.
  3. Shield Effectiveness:
    - i. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
    - ii. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
    - iii. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- N. Wall Brackets: Manufacturer's standard brackets.
- O. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

## 2.04 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

## 2.05 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91 at the factory prior to shipping to job site.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
- C. Prepare and submit test report indicating actual test data within two (2) weeks of completion of tests prior to shipping to job site. Test report shall be signed by the factory test technician or engineer and include comments by the testing engineer or supervisor. Include their name, date and location

# **PART 3 - EXECUTION**

## 3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.02 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Brace wall-mounting transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- C. Transformers shall be installed at least six (6) inches from the adjacent wall or structure unless otherwise noted by the manufacturer. Verify with manufacturer's installation instructions before start of work.
- D. All conduits shall be isolated from the transformer enclosures by the use of neoprene grommets at conduit entrances to enclosure and the use of a grounding bushing. Flexible jumpers shall be installed for grounding continuity from enclosure to conduits or bus ducts.
- E. Where primary feeders come from the floor below, they shall terminate at the end of transformer enclosure with a metal grounding bushing with neoprene throat insert. Ground the bushing to the transformer enclosure.
- F. Where primary feeders come from overhead, the conduits shall enter the side of the transformer enclosure. The conduits within 36 inches of the enclosure shall be flexible steel.
- G. Where transformers are installed next to an indoor switchboard, secondary conductors shall be routed from transformer to secondary switchboard through a 12-inch long wiring gutter,

flanged and bolted to transformer enclosure and switchboard enclosure. Install a neoprene gasket between gutter and transformer enclosure and bond gutter to transformer enclosure with a flexible copper grounding strap.

### 3.03 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### 3.05 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

### 3.06 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

**END OF SECTION**

## SECTION 26 24 13

### SWITCHBOARDS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Service and distribution switchboards rated 600 V and less and between 800A to 4000A.
2. Surge Protective Devices (SPD).
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

###### B. Switchboard shall be front aligned.

###### C. Related Sections include the following:

1. Section 260526 "Grounding and Bonding for Electrical Systems".
2. Section 260536 "Cable Tray for Electrical Systems".
3. Section 260548 "Electrical Equipment Noise And Vibration Control, Seismic Restraint"
4. Section 260553 "Identification for Electrical Systems".
5. Section 260913 "Electrical Power Monitoring and Control" for communication features of power distribution system devices.
6. Section 260573 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
7. Section 263600 "Transfer Switches" for transfer switches that may be located in secondary distribution section.
8. Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" for transient voltage surge suppressors for low-voltage power, control, and communication equipment that may be located in secondary section.

##### 1.03 DEFINITIONS

- A. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. RFI: Radio-frequency interference.
- E. RMS: Root mean square.
- F. SPDT: Single pole, double throw.



G. AIC: Interrupting capacity (RMS symmetrical) in amperes.

#### 1.04 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
2. Component Importance Factor: 1.0.
3. Component Amplification Factor: 2.5.
4. Component Response Modification Factor: 6.0.

#### 1.05 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

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

1. Include dimensioned plans, elevations, sections, and details, including required horizontal and vertical clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include evidence of UL NRTL listing for series rating of installed devices.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on log-log plotting; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

#### 1.06 INFORMATIONAL SUBMITTALS

A. Coordination Drawings for construction and record documentation.

B. Seismic Qualification Certificates for client record: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Submit of completion of tests along side findings for PV systems and generator systems in joint coordination.

#### 1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for switchboards and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log plotting; include selectable ranges for each type of overcurrent protective device.

#### 1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  2. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

#### 1.09 QUALITY ASSURANCE

- A. If alternate manufacturer of products other than what are specified in this section are submitted, all necessary documents not limited to cut sheets, technical information, test reports from recognized testing labs and factory test reports shall be submitted to the satisfaction of the owner/engineer to ensure quality and conformance to the specifications. Additional testing shall be undertaken if it is concluded by the owner/engineer that the submitted test reports are either insufficient or do not include all tests necessary for product acceptance. The tests shall be conducted by a recognized lab acceptable to the owner/engineer and all tests shall be witnessed by owner's/engineer's personnel. All testing procedures and test results shall be satisfactory to the owner/engineer. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one owner's/engineer's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Switchboards similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 or 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Switchboards shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., circuit breakers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Switchboard shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., primary switch, transformer, and switchboard) shall be manufactured within six months of installation.
- H. Source Limitations: Obtain switchboards, overcurrent protective devices and accessories through one source from a single manufacturer through a local distributor unless otherwise indicated. All power distribution equipment shall be of the same manufacturer as the substation.

- I. Comply with NEMA PB 2.
- J. Comply with NFPA 70.
- K. Comply with UL 891.
- L. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- M. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchboards and are based on the specific system indicated. Refer to Part 2 "Product Requirements."
- N. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100 and marked for intended location and application.
- O. Testing Agency Qualifications: Member of NETA;
  - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and technicians involved with testing of switchboards and OCPDs similar to those specified on this project.
  - 2. Testing company shall be located within 50 miles radius of the project.
  - 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
  - 4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of switchboards similar to the type and rating specified on this project.
- P. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products in accordance with manufacturer's recommended practices and as listed in Installation and Maintenance Manual.
- B. Each switchboard section shall be shipped in individual shipping splits for ease of handling. They shall be mounted on shipping skids and individually wrapped.
- C. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path at site.
- D. Inspect and report damage to carrier within their required time period.
- E. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- F. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage.
- G. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- H. Handle and prepare switchboards for installation according to NECA 400.

1.11 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - i. Ambient Temperature: Not exceeding 104 deg F.
    - ii. Altitude: Not exceeding 6600 feet.
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
  2. Altitude not exceeding 6600 feet.
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Architect, Construction Manager, Owner no fewer than fourteen (14) days in advance of proposed interruption of electric service.
  2. Do not proceed with interruption of electric service without Owner's written permission.
  3. All utility shutdowns will be done by Owner's authorized personnel unless otherwise noted. Coordinate through Owner's Representative.
  4. Comply with NFPA 70E.
  5. Provide temporary standby power through a standby diesel quiet type back-up generator complete with fuel and 7/24 monitoring if the existing service interruption exceeds 2 hours. Coordinate additional requirements with owner minimum fourteen days in advance. Indicate method of providing temporary electric service.

#### 1.12 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

#### 1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SURGE PROTECTION DEVICES that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Five (5) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric
  2. GE Consumer & Industrial by ABB - Electrical Distribution.
- B. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted unless otherwise indicated.
  2. Sections front and rear aligned.
- C. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Indoor Enclosures: Steel, NEMA 250, Type 1.
- E. Outdoor Enclosures: Type 3R.
1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
  2. Enclosure: bolt-on rear covers for each section, with provisions for padlocking.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Barriers: Between adjacent switchboard sections.
- H. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- I. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- J. Customer Metering Compartment: A separate customer metering compartment, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks. Coordinate with Colton Electrical Utility for programming.
- K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- M. Pull Box on Top of Switchboard:
1. Provide a proper size (per NEC) pull box on the top of the switchboard.
  2. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
  3. Set back from front to clear circuit-breaker removal mechanism.
  4. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
  5. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
  6. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

N. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, copper feeder circuit-breaker line connections.
2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
3. Ground Bus: 1/4-by-2-inch- hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

O. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of .

## 2.02 SURGE PROTECTIVE DEVICES (SPD)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Square D; a brand of Schneider Electric.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

B. Surge Protection Device Description: IEEE C62.41-compliant, externally mounted, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses rated at 200-kA interrupting capacity.
2. disconnect switch.
3. Redundant suppression circuits.
4. Redundant replaceable modules.
5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
6. LED indicator lights for power and protection status.
7. Audible alarm, with silencing switch, to indicate when protection has failed.
8. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
9. Four-digit, transient-event counter set to totalize transient surges.

C. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

D. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 and 208Y/120-V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 ;400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277; 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277; 400 V for 208Y/120.

## 2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity (AIC) to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; field replaceable and the following field-adjustable settings:
  - i. Instantaneous trip.
  - ii. Long- and short-time pickup levels.
  - iii. Long- and short-time time adjustments.
  - iv. Ground-fault pickup level, time delay, and I<sup>2</sup>t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
  - i. Standard frame sizes, trip ratings, and number of poles.
  - ii. Lugs: Mechanical or compression style, suitable for number, size, trip ratings, and conductor material.
  - iii. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
  - iv. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - v. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - vi. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
  - vii. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

- viii. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  - ix. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- B. Insulated-Case Circuit Breaker (ICCB): 80 and 100 percent rated per plans, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
- 1. Fixed circuit-breaker mounting.
  - 2. Two-step, stored-energy closing.
  - 3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - i. Instantaneous trip.
    - ii. Long- and short-time time adjustments.
    - iii. Ground-fault pickup level, time delay, and I<sup>2</sup>t response.
  - 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - 5. Remote trip indication and control.
  - 6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
  - 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - 8. Control Voltage: 120-V ac.

## 2.04 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
- 1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 2. Control-Power Transformers: by manufacturer where applicable.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
- 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - i. Phase Currents, Each Phase: Plus or minus 1 percent.
    - ii. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - iii. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - iv. Megawatts: Plus or minus 2 percent.
    - v. Megavars: Plus or minus 2 percent.
    - vi. Power Factor: Plus or minus 2 percent.
    - vii. Frequency: Plus or minus 0.5 percent.
    - viii. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.



- ix. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
  - x. Contact devices to operate remote impulse-totalizing demand meter.
- 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
  - 3. Digital Meter shall be manufactured by the one following manufacturers: Square D; Eaton-Cutler Hammer.

#### 2.05 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control Circuits: 120-V ac, supplied from remote branch circuit.
- C. Respective voltages for Modbus and BACnet connections.
- D. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
- E. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- F. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units

#### 2.06 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

#### 2.07 IDENTIFICATION

- A. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
- B. Service Equipment Label: UL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

### **PART 3 - EXECUTION**

#### 3.01 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Examine switchboards before installation to verify compliance with approved shop drawings. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the owner.

#### 3.02 INSTALLATION

- A. Install switchboards and accessories according to NECA 400.

- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, surge protection devices, and instrumentation.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges in accordance with the recommendations of the Overcurrent Protective Device Short Circuit, Coordination and Arc Flash Study.
- H. Comply with NECA 1.

### 3.03 CONNECTIONS

- A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.04 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting, and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with

requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.05 FIELD QUALITY CONTROL

#### A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, start-up and to assist in testing.

#### B. Acceptance Testing Preparation:

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

#### C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. All tests shall be witnessed by owner's representative. Provide minimum fourteen (14) days advance notice.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Perform the following infrared scan tests and inspections and prepare reports:
  - i. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
  - ii. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
  - iii. Instruments and Equipment:
    - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

#### D. Switchboard will be considered defective if it does not pass tests and inspections.

#### E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.06 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Short Circuit, Coordination and Arc Flash Studies."

### 3.07 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.08 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

**END OF SECTION**

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## SECTION 26 24 16

### PANELBOARDS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
- B. Related Sections include the following:
  - 1. Section 260553 "Identification for Electrical Systems".
  - 2. Section 260573 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.

##### 1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RMS: Root mean square.
- D. SPDT: Single pole, double throw
- E. SPD: Surge Protective Device

##### 1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
  - 2. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest California Building Code (CBC).

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Include evidence of UL listing for series rating of installed devices. Series rated devices shall be permitted if specified on the drawings.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field Quality-Control Reports:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
  4. Submit within two (2) weeks of completion of tests.
- D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

#### 1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Keys: Two spares for each type of panelboard cabinet lock.
  2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
  3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.09 QUALITY ASSURANCE

- A. If alternate manufacturer of products other than what are specified in this section are submitted, all necessary documents not limited to cut sheets, technical information, test reports from recognized testing labs and factory test reports shall be submitted to the satisfaction of the owner/engineer to ensure quality and conformance to the specifications. Additional testing shall be undertaken if it is concluded by the owner/engineer that the submitted test reports are either insufficient or do not include all tests necessary for product acceptance. The tests shall be conducted by a recognized lab acceptable to the owner/engineer and all tests shall be witnessed by owner's/engineer's personnel. All testing procedures and test results shall be satisfactory to the owner/engineer. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one owner's/engineer's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Panelboards similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 or 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Panelboards shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., circuit breakers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Panelboard shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer on similar units as applicable for OSHPD projects.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g. Circuit breakers) shall be manufactured within six months of installation.
- H. Source Limitations: Obtain panelboards, overcurrent protective devices and accessories through one source from a single manufacturer through a local distributor unless otherwise indicated. All power distribution equipment shall be of the same manufacturer as the substation.
- I. Comply with NFPA 70.
- J. Comply with NEMA PB 1.
- K. Comply with UL 891.
- L. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- M. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Part 2 "Product Requirements."
- N. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100 and marked for intended location and application.
- O. Testing Agency Qualifications: Member of NETA;
  1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and



technicians involved with testing of switchboards, panelboards and OCPDs similar to those specified on this project.

2. Testing company shall be located with 50 miles radius of the project.
3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of switchboards similar to the type and rating specified on this project.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

#### 1.11 PROJECT CONDITIONS

- A. Environmental Limitations:
  1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - i. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    - ii. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  1. Ambient temperatures within limits specified.
  2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  1. Notify Architect Construction Manager Owner no fewer than 14 days in advance of proposed interruption of electric service.
  2. Do not proceed with interruption of electric service without Owner's written permission.
  3. Comply with NFPA 70E.

#### 1.12 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

### 1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
1. Rated for environmental conditions at installed location.
    - i. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - ii. Outdoor Locations: NEMA 250, Type 3R with 3-point latch.
  2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  3. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections. No splices shall be permitted inside gutters.
  4. Finishes:
    - i. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat or Powder coated
    - ii. Back Boxes: Same finish as panels and trim.
    - iii. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
  5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Main and Neutral Lugs: Compression type.
  3. Ground Lugs and Bus-Configured Terminators: Compression type.
  4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- F. Service Equipment Label: UL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard shall be listed and labeled with UL short circuit rating. If Series Rated Panelboard is specified-the panelboard shall be rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by UL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by UL.
- I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.02 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
  1. Square D; a brand of Schneider Electric
  2. GE Consumer & Industrial by ABB - Electrical Distribution.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Interiors shall be completely factory assembled. These shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus interiors.
- D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  1. For doors more than 36 inches high, provide two latches, keyed alike.
- E. Mains: Circuit breaker or Lugs only.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Where indicated, provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure.

## 2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
  1. Square D; a brand of Schneider Electric
  2. GE Consumer & Industrial by ABB - Electrical Distribution.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Door-in-door type. Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.04 LOAD CENTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers

1. Square D; a brand of Schneider Electric
  2. GE Consumer & Industrial by ABB - Electrical Distribution.
- B. Load Centers: Comply with UL 67.
- C. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- D. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

## 2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
1. Square D; a brand of Schneider Electric
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Where indicated provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure.
  2. Thermal-Magnetic Circuit Breakers (below 600A frame): Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Provide field adjustable magnetic trip setting for circuit-breakers serving motor loads or other special applications as indicated
  3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  4. Electronic trip circuit breakers (600A frame size and larger) with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
    - i. Instantaneous trip.
    - ii. Long- and short-time pickup levels.
    - iii. Long- and short-time time adjustments.
    - iv. Ground-fault pickup level, time delay, and  $I^2t$  response.
    - v. CBs shall have an integral power supply installed at the factory if required for proper functioning of the breaker. An external power supply shall not be acceptable.
  5. Circuit breakers shall have a minimum interrupting rating of 10,000 amperes RMS symmetrical at 240 volts, and 14,000 amperes RMS symmetrical at 480 volts, unless otherwise noted on the drawings. Verify maximum available fault levels from the Short Circuit and Coordination Study. Minimum interrupting rating (AIC) shall be 110% of the available fault level.
  6. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  7. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  8. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  9. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

10. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

- i. Standard frame sizes, trip ratings, and number of poles.
- ii. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
- iii. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
- iv. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- v. Communication Capability: communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
- vi. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
- vii. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
- viii. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- ix. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- x. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- xi. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
- xii. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
- xiii. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- xiv. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.

2.06 PANELBOARD SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
  1. Square D; a brand of Schneider Electric
  2. Current Technology; a subsidiary of Danahar Corporation.
  3. GE Consumer & Industrial by ABB - Electrical Distribution.
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
  1. Accessories:

- i. LED indicator lights for power and protection status.
  - ii. Audible alarm, with silencing switch, to indicate when protection has failed.
  - iii. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, plug-in or bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
  - 1. Accessories:
    - i. Fuses rated at 200-kA interrupting capacity.
    - ii. Fabrication using bolted compression lugs for internal wiring.
    - iii. Integral disconnect switch.
    - iv. Redundant suppression circuits.
    - v. Redundant replaceable modules.
    - vi. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
    - vii. LED indicator lights for power and protection status.
    - viii. Audible alarm, with silencing switch, to indicate when protection has failed.
    - ix. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
    - x. Six-digit, transient-event counter set to totalize transient surges.
  - 2. Peak Single-Impulse Surge Current Ratings: 80 kA per mode/160 kA per phase.
  - 3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
    - i. Line to Neutral: 65,000 A.
    - ii. Line to Ground: 65,000 A.
    - iii. Neutral to Ground: 50,000 A.
  - 4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
  - 5. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 and 208Y/120-V, three-phase, four-wire circuits shall be as follows:
    - i. Line to Neutral: 800 V for 480Y/277; 400 V for 208Y/120.
    - ii. Line to Ground: 800 V for 480Y/277 ; 400 V for 208Y/120.
    - iii. Neutral to Ground: 800 V for 480Y/277; 400 V for 208Y/120.

## 2.07 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install panelboards and accessories according to NECA 407.
- B. Equipment Mounting: Install panelboards deeper than 11" on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 / 033053 "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
  - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
  - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Mount top of trim 90 inches above finished floor unless otherwise indicated. Mounting height of Over Current Protective Devices shall be 6"7" above finished floor to the center of the grip of device operating handle unless a lower height is indicated or required by code.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

### 3.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - i. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - ii. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    - iii. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.05 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.



- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
  - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.06 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

**END OF SECTION**

## SECTION 26 27 13

### ELECTRICITY METERING

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes equipment for electricity metering by utility company and electricity metering by Owner.

##### 1.03 DEFINITIONS

- A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data for each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
  - 1. Dimensioned plans and sections or elevation layouts.
  - 2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
- C. Manufacturer Seismic Qualification Certification for Electricity-Metering Equipment for client record: Submit certification that equipment components and their mounting and anchorage provisions have been designed to remain in place without separation of any parts or loosening of factory-made connections when subjected to the seismic forces and shall include the following:
  - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculations.
  - 2. Detailed description of equipment mounting and anchorage devices on which the certification is based and their installation requirements.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Application and operating software documentation.
  - 2. Software licenses.
  - 3. Software service agreement.
  - 4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70 and marked for intended location and application.
- B. Owner's Meters in switchgear/switchboard/distribution board shall be installed by the manufacturer at the factory.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, store, and handle modular meter center according to NECA 400.

1.09 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted in writing under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Construction Manager and Owner no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Construction Manager and Owner written permission.
  - 3. Comply with NFPA 70E.
  - 4. Provide temporary standby power through a standby diesel quiet type back-up generator complete with fuel and 7/24 monitoring if the existing service interruption exceeds 2 hours. Coordinate additional requirements with owner minimum fourteen days in advance. Indicate method of providing temporary electric service.

1.10 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
  - 1. Comply with requirements of utilities providing electrical power services.
  - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.11 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years from the date of acceptance of the project by the owner.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software at no additional cost to the owner.
  - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

**PART 2 - PRODUCTS**

2.01 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- C. Meter Sockets: Comply with requirements of electrical-power utility company.

- D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
- E. Modular Meter Center: Factory-coordinated assembly of a main service disconnect device, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
    - i. Square D; a brand of Schneider Electric – w/ ECC technology
    - ii. Electrotech Industries
  2. Comply with requirements of utility company for meter center. Utility Meters shall be certified by Colton Utility EUSERC.
    - i. Comply with UL 67.
  3. Housing: NEMA 250, Type 3R enclosure.
  4. Minimum Short-Circuit Rating: 65,000 A symmetrical at rated voltage.
  5. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers.
  6. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
  7. Surge Protection: For main disconnect device, comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
- F. Arc-Flash Warning Labels;
1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 260573.19 "Arc-Flash Studies." Apply a 3-1/2-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.
  2. Labels: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply a 3-1/2-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
    - i. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
      - 1) Location designation.
      - 2) Nominal voltage.
      - 3) Flash protection boundary.
      - 4) Hazard risk category.
      - 5) Incident energy.
      - 6) Working distance.
  3. Engineering report number, revision number, and issue date.

## 2.02 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Square D; a brand of Schneider Electric
  2. Electrotech Industries
- B. General Requirements for Owner's Meters:
1. Comply with UL 1244.
  2. Meters used for billing shall have an accuracy of 0.2 percent of reading, complying with requirements in ANSI C12.20 minimum, and abide to minimum revenue grade per Colton Electrical Utility at +/- 2% accuracy per ANSI C12.1-2008.
  3. Enclosure: NEMA 250, Type 3R minimum, with hasp for padlocking or sealing where integral is not feasible.
  4. Meters installed outdoor shall be in NEMA 4X stainless steel enclosure. Meter in enclosure shall be factory installed and assembled with strip heaters controlled by thermostat.
  5. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
  6. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
  7. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
    - i. Type: Split and solid core and abide to City of Colton electrical Utility and accuracy requirements.
  8. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
  9. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to switchboard Energy Control Center and building BMS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system. Protocols for both Modbus and BACnet
- C. Kilowatt-hour Meter: Electronic three-phase meters, measuring electricity used.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
  2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.
- D. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
  2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.
- E. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

- F. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing/ production per Colton Electrical Utility.
- G. Accessories:
  - 1. Fuses: Provide fuses to protect meters.
  - 2. Shunting Devices: Provide shunting devices for maintenance of meters.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION**

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.
- D. Install arc-flash labels as required by NFPA 70.
- E. Wiring Method:
  - 1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
  - 2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
  - 3. Minimum conduit size shall be 1/2 inch (13 mm).

#### **3.02 IDENTIFICATION**

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
  - 2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

#### **3.03 FIELD QUALITY CONTROL**

- 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
  - 2. Turn off circuits supplied by metered feeder and secure them in off condition.
  - 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
  - 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results. This

shall be done in the presence of Owner's Meter Shop Personnel. Coordinate through Owner's Representative.

- C. Electricity metering will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Provide simultaneous in-field coordination with service representatives for generator controls, PV system, Colton Electrical Utility, Switchboard Manufacturer Energy Control Systems, and Mechanical Building Management System vendor for complete controls.

**END OF SECTION**

NOT FOR BID

## SECTION 26 27 26

### WIRING DEVICES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. USB receptacles.
3. SPD receptacles, 125 V, 20 A.
4. Twist-locking receptacles.
5. Weather-resistant receptacles.
6. Snap switches and wall-box dimmers.
7. Wall-switch and exterior occupancy sensors.
8. Communications outlets.
9. Toggle switches, 120/277 V, 20 A.
10. Decorator-style devices, 20 A.
11. Cord and plug sets.
12. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

##### 1.03 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- E. RFI: Radio-frequency interference.
- F. SPD: Surge Protective Device.
- G. UTP: Unshielded twisted pair.

##### 1.04 ADMINISTRATIVE REQUIREMENTS

###### A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.



1.06 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Floor Service-Outlet Assemblies: One for every 4, but no fewer than one.
  - 2. Poke-Through, Fire-Rated Closure Plugs: One for every 4 floor service outlets installed, but no fewer than two.

1.09 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer. Switches, receptacles and cover plates shall be of the same manufacturer.
- B. Comply with National Electrical Manufacturer's Association (NEMA) standards. Furnish products listed and classified by Underwriter's Laboratories Inc. as suitable for purpose specified and shown.
- C. Manufacturer shall have a minimum of ten (10) years experience in the production of wiring devices specified and shall have ISO 9001 and 9002 certifications.

**PART 2 - PRODUCTS**

2.01 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  - 1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 2. Leviton Mfg. Company Inc. (Leviton).
  - 3. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: UL Listed and labeled, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Heavy duty spec grade.

2.03 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125V, 20A: Comply with NEMA WD1, NEMAWD6 Configuration 5-20R, UL498, and FSW-C-596.
- B. Decorator Style shall be used for recessed wall mount at all front of house areas: offices, conference rooms, exposed convenience outlets, etc.
  - 1. Products: Subject to compliance with requirements, provide one of the following manufacturers :

- i. Hubbell; HBL5361 (single), HBL5362 (duplex).
  - ii. Leviton; 5361 (single), 5362 (duplex).
  - iii. Pass & Seymour; 5361 (single), 5362 (duplex).
- 2. Description: Grounded, industrial extra heavy duty specifications grade, back- and side-wired, single-piece grounding brass strap with integral ground, impact-resistant thermoplastic nylon cover and body, smooth face, with separate grounding screw and NEMA 5-20R plug configurations.
- C. Weather-Resistant Duplex Receptacle, 125 V, 20 A
  - 1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Standards: Comply with UL 498.
- D. Controlled Duplex Receptacles, 125 V, 20A (same as Convenience Receptacles)
- E. USB Charging Receptacles:
  - 1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
  - 2. USB Receptacles: Dual, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
  - 3. Standards: Comply with UL 1310 and USB 3.0 devices.
  - 4. Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.

## 2.04 GFCI RECEPTACLES

- A. General Description:
  - 1. Straight blade, feed-through type.
  - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
  - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
  - 1. Products: Subject to compliance with requirements, :
    - i. Hubbell; GFR5352L.
    - ii. Pass & Seymour; 2095.
    - iii. Leviton; 7590.

## 2.05 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
  - 1. Products: Subject to compliance with requirements, :
    - i. Hubbell; HBL2310.
    - ii. Leviton; 2310.
    - iii. Pass & Seymour; L520-R.

## 2.06 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following manufacturers :

- i. Single Pole:
- ii. Hubbell; HBL1221.
  - 1) Leviton; 1221-2.
  - 2) Pass & Seymour; CSB20AC1.
- iii. Two Pole:
- iv. Hubbell; HBL1222.
  - 1) Leviton; 1222-2.
  - 2) Pass & Seymour; CSB20AC2.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following manufacturers :

- i. Hubbell; HBL1201PL for 120 and 277 V.
- ii. Leviton; 1221-LH1.
- iii. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

- i. Hubbell; HBL1221L.
- ii. Leviton; 1221-2L.
- iii. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.07 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following manufacturers :

- i. Hubbell; DR20.
- ii. Leviton; 16252.
- iii. Pass & Seymour; 26252.

- B. Tamper-Resistant Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following manufacturers :

- i. Hubbell; DR20TR.
- ii. Pass & Seymour; TR26252.

2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

- C. Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following manufacturers :
    - i. Hubbell; DR20TR.
    - ii. LevitonTRW20.
    - iii. Pass & Seymour; TRW26252.
  2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.
- D. GFCI, Feed-Through Type, Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and UL 943 Class A.
1. Products: Subject to compliance with requirements, provide one of the following manufacturers :
    - i. Hubbell; GF20LA.
    - ii. Leviton; 8599.
    - iii. Pass & Seymour; 2094.
- E. GFCI, Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and UL 943 Class A.
1. Products: Subject to compliance with requirements, provide one of the following manufacturers :
    - i. Hubbell; GFTR20.
    - ii. Pass & Seymour; 2094TRWR.
  2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- F. Toggle Switches, Square Face, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
1. Products: Subject to compliance with requirements, provide one of the following manufacturers :
    - i. Hubbell; DS120 (single pole), DS320 (three way).
    - ii. Leviton; 5621-2 (single pole), 5623-2 (three way).
    - iii. Pass & Seymour; 2621 (single pole), 2623 (three way).

## 2.08 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
  2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
  3. Material for Unfinished Spaces: Galvanized steel.
  4. Material for Damp Locations: Cast aluminum with in-use cover, and listed and labeled for use in wet and damp locations.

- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable in-use cover.

## 2.09 FLOOR SERVICE FITTINGS

A. Type:

1. Power and data combination (steel): Legrand evolution series with concrete pour RFB6E Series, barrier separates power from voice and data communication cabling, and accessories. Coordinate with division 27. 2 circuit, quadraplex 5-20R.
2. Flush Power Receptacle (steel): HUBBELL S1SFB series; S1 series metal cover Compartments (or Legrand equal). 2 circuit, quadraplex or 1 circuit duplex per plans.

B. Modular, flush-type, dual-service units suitable for wiring method used.

C. Compartments: Barrier separates power from voice and data communication cabling.

D. Flush Cover Service Plate: Heavy duty series 6CTHDSS, set screw lockable, die-cast with satin finish.

E. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

F. Voice and Data Communication Outlet: See telecommunications and audio/visual documents for requirements.

## 2.10 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Coordinate with division 27, subject to compliance with requirements, provide products by one of the following:

1. Wiremold / Legrand.
2. Hubbell Incorporated; Wiring Device-Kellems.

B. Type:

1. Power and data combination (recessed): For power/data: Legrand Evolution 8 series: metal cover, 2 circuit, quadraplex 5-20R.
2. Power receptacle (surface): HUBBELL S1PTFIT SERIES ; S1 series metal cover, lockable. 2 circuit, quadraplex or 1 circuit duplex per plans (or Legrand equal)

C. Description:

1. Flush Cover Service Plate: Heavy duty series 6CTHDSS, set screw lockable, die-cast with satin finish.
2. Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
3. Comply with UL 514 scrub water exclusion requirements.
4. Service-Outlet Assembly: Flush type with divisible compartments allowing for installation of power, audiovisual and communications cabling complying with requirements in Section 271513 Copper Horizontal Cabling
5. Size: Selected to fit upto nominal 8-inch cored holes in floor and matched to floor thickness.
6. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
7. Wiring Raceways and Compartments: Shall have a minimum of three center mount device plates and two 20a duplex outlets. Raceways to accommodate separate pathways for power, audiovisual and communications cabling, four-pair cables that comply with requirements in Section 271513 "Copper Horizontal Cabling"

8. Contractor shall provide adequate conduit length to allow junction box to extend below floor slab.

#### 2.11 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
  1. Hubbell Incorporated; Wiring Device-Kellems.
  2. Wiremold/Legrand.
  3. (final approved furniture vendor)
- B. Description:
  1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
  2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.

#### 2.12 FINISHES

- A. Device Color:
  1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  2. Wiring Devices Connected to Emergency Power System: Red.
- B. Wall Plate Color: For plastic covers, match device color.

### **PART 3 - EXECUTION**

#### 3.01 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:

- i. Straighten conductors that remain and remove corrosion and foreign matter.
- ii. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 20-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports. Submit reports within two (2) weeks of completion of tests.

**END OF SECTION**



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## SECTION 26 28 13

### FUSES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
2. Spare-fuse cabinets.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
  - i. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
  - ii. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

##### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

##### 1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.07 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.08 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

## PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Littelfuse, Inc.
  2. Cooper Bussmann, Inc.
  3. Edison Fuse, Inc.
  4. Ferraz Shawmut, Inc.

2.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
  2. Finish: Gray, baked enamel.
  3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
  4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 FUSE APPLICATIONS**

- A. Cartridge Fuses:
  - 1. Service Entrance: Class L, fast acting.
  - 2. Feeders: Class L, fast acting.
  - 3. Motor Branch Circuits: Class RK1, time delay.
  - 4. Other Branch Circuits: Class RK1, time delay.
  - 5. Control Circuits: Class CC, fast acting.

### **3.03 INSTALLATION**

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

### **3.04 IDENTIFICATION**

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

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## SECTION 26 28 16

### ENCLOSED SWITCHES AND CIRCUIT BREAKERS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Shunt trip switches.
  - 4. Molded-case circuit breakers (MCCBs).
  - 5. Molded-case switches.
  - 6. Enclosures.

##### 1.03 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

##### 1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on graphed log-log.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Manufacturer's field service report.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on plotted log-log paper.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Fuse Pullers: Two for each size and type.

1.09 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect Construction Manager Owner no fewer than 14 days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**PART 2 - PRODUCTS**

2.01 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Square D; a brand of Schneider Electric.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

C. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 240 and 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.



2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

## 2.02 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Square D; a brand of Schneider Electric.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.03 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Cooper Bussmann, Inc.
  2. Ferraz Shawmut, Inc.
  3. Littelfuse, Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer or source (per elevator installer) of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
  1. Oiltight key switch for key-to-test function.
  2. Oiltight red ;green ;white; yellow (per elevator installer) ON pilot light.
  3. Isolated neutral lug; 100 percent rating.
  4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.

5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac ; 24-V dc coil voltage (per elevator installer).
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

## 2.04 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Square D; a brand of Schneider Electric.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  1. Instantaneous trip.
  2. Long- and short-time pickup levels.
  3. Long- and short-time time adjustments.
  4. Ground-fault pickup level, time delay, and I<sup>2</sup>t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- H. Features and Accessories:
  1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  3. Application Listing: Appropriate for application.
  4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
  6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

8. Auxiliary Contacts: One or two SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Electrical Operator: Provide remote control for on, off, and reset operations.
10. Accessory Control Power Voltage: Integrally mounted, self-powered.

## 2.05 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  2. Outdoor Locations: NEMA 250, Type 3R.
  3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  5. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 or 9.

## **PART 3 - EXECUTION**

### 3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

### 3.03 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  3. Perform the following infrared scan tests and inspections and prepare reports:
    - i. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - ii. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    - iii. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

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## SECTION 26 31 00

### PHOTOVOLTAIC COLLECTORS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. PV system description.
  - 2. Manufactured PV units.
  - 3. PV module framing.
  - 4. Inverters.
  - 5. System overcurrent protection.

##### 1.03 DEFINITIONS

- A. CEC: California Energy Commission.
- B. ETFE: Ethylene tetrafluoroethylene.
- C. FEP: Fluorinated ethylene propylene.
- D. IP Code: Required ingress protection to comply with IEC 60529.
- E. MPPT: Maximum power point tracking.
- F. PTC: PVUSA Test Condition. Commonly regarded as a "real-world" measure of PV output. See below for definition of "PVUSA."
- G. PV: Photovoltaic.
- H. PVUSA: Photovoltaics for Utility Systems Applications.
- I. STC: Standard Test Conditions defined in IEC 61215.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Final Warranty to client: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

##### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data to client: For PV modules to include in operation and maintenance manuals.
- B. As-built Drawings for record to client: For PV modules.
  - 1. Include diagrams for power, signal, and control wiring connections.

#### 1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. PV installer shall be qualified in commercial solar photovoltaic installations with minimum 5 years experience.

#### 1.08 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.
  - 1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:
    - i. Faulty operation of PV modules.
    - ii. Inverter failure
  - 2. Warranty Period: 25 years from date of Substantial Completion.
- B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
  - 1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:
    - i. Modules will be at least 98% of the Minimum Peak Power rating for the first year, and will decline by no more than 0.25% per year for the following 24 years, so the power output at the end of the final year of the 25th year warranty period will be at least 92% of the Minimum Peak Power rating (the "Guaranteed Peak Power" rating)..

### **PART 2 - PRODUCTS**

#### 2.01 MANUFACTURED UNITS

- A. Sunpower SPR-A440-COM

#### 2.02 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Seismic Qualification: For PV System accessories, and components, from manufacturer.
  - 1. Detailed description of equipment anchorage devices and their installation requirements.

#### 2.03 PV CAPACITIES AND CHARACTERISTICS

- A. Electrical Characteristics:
  - 1. Shall comply with equipment indicated on plans

#### 2.04 PV SYSTEMS DESCRIPTION

- A. Interactive PV System: Collectors connected in parallel to the electrical utility; and capable of providing power for Project and supplying power to a distributed network.
  - 1. System Components:
    - i. PV modules.

- ii. Array frame.
- iii. Utility-interactive inverter.
- iv. Overcurrent protection, disconnect, and rapid shutdown devices.
- v. Mounting structure.
- vi. Utility Approved submeter capable of revenue accuracy and integrated with final approved service switchboard equipment.

## 2.05 MANUFACTURED PV UNITS

- A. Cell Materials: Monocrystalline IBC cells.
- B. Module Construction:
  - 1. Weights and dimensions per products indicated on plans.
- C. Front Panel: tempered glass.
- D. Front Panel: Antireflective coating glass.

## 2.06 PV MODULE FRAMING

- A. PV laminates mounted in anodized extruded-aluminum frames.
  - 1. Entire assembly UL listed for electrical and fire safety, Class A, according to UL 1703, and complying with IEC 61215.
  - 2. Frame strength exceeding requirements of certifying agencies in subparagraph above.
  - 3. Finish: Anodized aluminum.
    - i. Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish.
    - ii. Color: As indicated by manufacturer's designations.

## 2.07 PV ARRAY CONSTRUCTION

- A. Framing: Refer to structural canopy designs and specifications.

## 2.08 PV CONDUCTORS

- A. Module DC conductors: Type listed PV - XLPE/RHW-2
  - 1. UL 4703 - 2000V rated insulation -40°C and 90°C in wet and 105°C in dry conditions
  - 2. UV and weather resistant
  - 3. Kristech or approved equal

## 2.09 INVERTER

- A. Inverter Type: Both Microgrid and Utility direct functionality.
- B. Control Type: Maximum power point tracker control.
- C. Inverter Characteristics: per product indicated on plans.

## 2.10 IDENTIFICATION

- A. PV System - Separate colorcoding tape
  - 1. UV and weather resistant
  - 2. Red for positive + and black for negative – polarity of PV circuit conductors.
  - 3. Apply at all accessible points of termination, connection, and splices: each module lead, homerun circuit, and terminal at inverter.



## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Do not begin installation until mounting surfaces have been properly prepared.
- C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.
- E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Comply with NECA 1.
- B. Coordinate layout and installation of PV panels with support assembly and other construction.
- C. Support PV panel assemblies independent of supports for other elements such as roof and support assemblies, enclosures, vents, pipes, and conduits. Support assembly to prevent twisting from eccentric loading.
- D. Install PV inverters, charge controller, rapid shutdown, and system control in locations indicated on Drawings.
- E. Install weatherseal fittings and flanges where PV panel assemblies penetrate exterior elements such as walls, roofs, and structural framing. Seal around openings to make weathertight. See Division 07 for acceptable Joint Sealants for materials and application.
- F. Seismic Restraints: Comply with requirements per structural specifications and plans.
- G. PV module connector leads loop excess connector leads to module frame/rack, and fasten such that slack is minimized. Wire clip with weatherproof hardware (Hubbell ACC-PV, etc)
- H. Wiring Method: Install cables and DC string homeruns in raceways (excluding module leads and where specifically noted in plans). Fasten conductors with 1.4 m (4'-1/2 ft) max and within 300 mm (12 in.) max of every cable entry into enclosures such as outlet boxes, junction boxes, cabinets, or fittings. Include 's' curve/loop of slack for both AC and DC conductors at terminations
- I. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools. Include 3" slack loops.

### **3.03 CONNECTIONS**

- A. Coordinate PV panel cabling to equipment enclosures to ensure proper connections.
- B. Coordinate installation of utility required systems. System shall microgrid in island mode during operation of either main utility or standby generators.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- D. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- E. Provide simultaneous in-field coordination with service representatives for generator controls, PV system, Colton Electrical Utility, Switchboard Manufacturer Energy Control Systems, and Mechanical Building Management System vendor for complete controls.

**END OF SECTION**

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## SECTION 26 32 13

### ENGINE GENERATORS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes packaged engine-generator sets for both emergency and optional standby power supply with the following features:
  - 1. Diesel engine.
  - 2. Generators
  - 3. Unit-mounted cooling system.
  - 4. Unit-mounted control and monitoring.
  - 5. Performance requirements for sensitive loads.
  - 6. Outdoor enclosure.
  - 7. Battery charger.
  - 8. Day tank.
  - 9. Muffler.
  - 10. Remote annunciator.
  - 11. Starting battery and charger.
  - 12. Active diesel particulate filter (DPF) where applicable to AQMD.
  - 13. Independent DPF support structure where applicable to AQMD.
- B. Related Sections include the following:
  - 1. Section 260526 "Grounding and Bonding for Electrical Systems."
  - 2. Section 262416 "Panelboards"
  - 3. Section 262816 Enclosed Switches and Circuit Breakers.
  - 4. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

##### 1.03 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. NETA: InterNational Electrical Testing Association
- C. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

##### 1.04 STANDARDS

- A. National Electrical Manufacturer's Association (NEMA).
- B. National Fire Protection Association (NFPA).

- C. California Electric Code (CEC).
- D. California Air Resource Board (CARB).
- E. County of San Diego Air Pollution Control District (SDAPCD).
- F. South Coast Air Quality Management District (SCAQMD)

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
  - 1. Thermal damage curve for generator.
  - 2. Time-current characteristic curves for generator protective device.
  - 3. Technical data sheets of each equipment.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
  - 2. Brake horsepower of engine.
  - 3. Include fuel consumption in gallons per hour (liters per hour) at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity..
  - 4. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
  - 5. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 6. Include thermal damage curve for generator.
  - 7. Include time-current characteristic curves for generator protective device. Cooling air requirements and its design.
  - 8. Noise db level.
  - 9. Electrical characteristics of generator, voltage regulator, and battery charger.
  - 10. Control panel.
  - 11. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams indicating terminal markings for engine generators and functional relationship between all electrical components.
  - 12. Elevations of equipment including front elevation, side elevation, top view for complete assembly.
  - 13. Engine and generator details, including governor, turbocharger, exciter, after/intercooler, **DPF**, day tank, main fuel storage tank and associated required pumping drawings.
  - 14. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
  - 15. Certified independent test lab data of generator characteristics, verification of emissions conformance to latest applicable regulations of CARB and AQMD where required by permitting.
  - 16. Main line circuit breaker.

17. Vibration Isolation Base Details where applicable: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
18. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
19. Indicate name and place of manufacture of each major component.
20. DPF Support Structure Design Calculations and Details, where required by permitting: Signed and sealed by a qualified professional engineer. Calculate requirements and provide design details for the structural support and anchorage of the DPF and associated equipment. The support structure shall support the DPF above, and independent from, the generator enclosure.

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - i. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Manufacturer's dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  4. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight, including full fuel tank, supplied enclosure, external silencer, subbase-mounted fuel tank, and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
- B. Coordination Drawings for construction.
- C. Where required for permit: Manufacturer's certified letter stating that unit complies with all California State Codes, Uniform Building Code (UBC), California Air Resource Board (CARB), California Electrical Code (CEC), latest edition and supplements and National Electric Manufacturer's Association (NEMA) standards for an emergency power plant.
- D. Sound levels shall be measured in the octave bands, having center frequencies from 31.5 Hz to 8000 Hz according to the procedures given in American National Standards Institute (ANSI) Standards S1.13.71. Measurements shall be made in at least four locations as described in the standard and shall be made at a distance of one meter from the surface of the equipment. Sound levels generated shall be within acceptable limits.
- E. Qualification Data: For installer, manufacturer and testing agency.
- F. Source quality-control test reports for client record.
  1. Certified summary of prototype-unit test report.
  2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Certified Test Report of factory tests on units to be shipped for this Project, showing evidence of compliance with specified requirements. Submit within two (2) weeks of completion of tests. Report shall be signed by a factory testing engineer.
4. Report of sound generation.
5. Where required for permitting: Report of exhaust emissions showing compliance with applicable regulations.
6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

G. Field quality-control test reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply (address and phone number of sources).

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
  2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
  3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
  4. Tools: Each tool listed by part number in operations and maintenance manual:

1.09 QUALITY ASSURANCE

- A. If alternate manufacturer of products other than what are specified in this section are submitted, all necessary documents not limited to cut sheets, technical information, test reports from recognized testing labs and factory test reports shall be submitted to the satisfaction of the owner/engineer to ensure quality and conformance to the specifications. Additional testing shall be undertaken if it is concluded by the owner/engineer that the submitted test reports are either insufficient or do not include all tests necessary for product acceptance. The tests shall be conducted by a recognized lab acceptable to the owner/engineer and all tests shall be witnessed by owner's/engineer's personnel. All testing procedures and test results shall be satisfactory to the owner/engineer. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one owner's/engineer's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Emergency/Standby Engine Generators similar to the type and size specified in this project. Furnish a list of three (3) contacts for the three (3) similar projects completed within the last 5 years. Include name, tele no and email of the facility engineers.
- D. Manufacturer shall have ISO 9001 or 9002 Certification.

- E. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- F. Engine Generators shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., circuit breakers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- G. Engine Generators shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer on similar units.
- H. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g. engines, generators, governors, controls) shall be manufactured within six months of installation.
- I. Source Limitations: Obtain packaged engine generators, and accessories through one source from a single manufacturer through a local distributor. Manufacturer of overcurrent devices shall match other power distribution equipment on the project.
- J. Comply with ASME B15.1.
- K. Comply with NFPA 37.
- L. Comply with NFPA 70.
- M. Comply with NFPA 110 requirements.
- N. Comply with UL 2200.
- O. Engine Exhaust Emissions: Comply with applicable state and local government requirements. Engine Exhaust Emissions: Apply and obtain a permit to construct and a permit to operate from Air Pollution Control District (authority having jurisdiction of the project) including payment of permit fees and health risk assessment fees. Contractor shall submit complete emission data along with the shop drawings for the generator set within six (6) weeks of receiving Notice to Proceed. Contractor shall not start installation without proper permits from the authority having jurisdiction.
- P. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- Q. Product Options: Drawings indicate size, profiles, and dimensional requirements of engine generators and are based on the specific system indicated. Refer to Part 2 "Product Requirements."
- R. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100—and marked for intended location and application.
- S. Testing Agency Qualifications: Member of NETA;
  - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and technicians involved with testing of switchboards, panelboards and OCPDs similar to those specified on this project.
  - 2. Testing company shall be located with 100 miles radius of the project.
  - 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
- T. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.



1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Where seismic and vibration systems are required in addition to those already in the structural designs, provide data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

#### 1.10 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  1. Notify Construction Manager and Owner no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
  2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  1. Ambient Temperature: 5 to 40 deg C.
  2. Relative Humidity: 0 to 95 percent.
  3. Altitude: Sea level to 1000 feet.

#### 1.11 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

#### 1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Two years from date of Substantial Completion, each unit.

#### 1.13 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 24 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Generac - basis shall be per equipment indicated on plans
  2. Caterpillar; Engine Div.

3. Cummins Power Generation.

2.02 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
- C. Capacities and Characteristics:
  - 1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
  - 2. Output Connections: Three-phase, four wire or Single phase three wire. Refer to drawings for more information.
  - 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator-Set Performance:
  - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
  - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
  - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined in accordance with NEMA MG 1, shall not exceed 50 percent.
  - 7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
  - 8. Start Time:
    - i. Comply with NFPA 110, Type 10 system requirements.
    - ii. 10 seconds.
- E. Parallel Engine Generators:
  - 1. Automatic reactive output power control and load sharing between engine generators operated in parallel.
  - 2. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.
  - 3. Protective relays required for equipment and personnel safety.

4. Paralleling suppressors to protect excitation systems.
5. Reverse power protection.
6. Loss of field protection.

## 2.03 ENGINE

- A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid-mounted.
  1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.
- E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.
  1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gauge glass and petcock.
  4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  5. Maximum Ambient Operating Temperature: 122 deg F (50 deg C).
  6. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
    - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- A. Muffler/Silencer: Critical type, super quiet, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. Provide stainless steel type muffler including pipe connection to engine where these are exposed to weather.
  1. Minimum sound attenuation of 25 dB at 500 Hz.
  2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

3. Level 1A attenuation
- B. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator. Provide new filters after completion for field tests and before acceptance by the owner.
- C. Starting System: 24-V electric, with negative ground.
  1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
  2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  3. Cranking Cycle: As required by NFPA 110 for system level specified.
  4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
  5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
  6. Battery Compartment, Battery-Charging Alternator: basis shall be per equipment indicated on plans.
  7. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
    - i. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    - ii. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    - iii. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    - iv. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    - v. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

#### 2.04 FUEL OIL STORAGE

- A. Comply with NFPA 30. Fuel system shall be complete and shall consist of a dual filtering system, fuel storage tank, day tank and engine fuel pump. Provide fuel for testing and full tank after testing. basis shall be per equipment indicated on plans
- B. Piping: Fuel-oil piping shall be Schedule 40 black steel Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system
- C. Fuel filtering – Industrial grade, Three-Stage Ultimate Fuel Filter and drum fuel tank kit.
  1. Steel mesh strainer

2. Water absorption
  3. Water separation
- D. Base-Mounted, Double-Wall Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
1. Tank level indicator.
  2. Capacity: per plans.
  3. Leak detection in interstitial space.
  4. Vandal-resistant fill cap.
  5. Each: Level 1A sound attenuation enclosure with low profile tank with 20 hour full capacity: 1,001 gallons. Total footprint dimensions with generator: 247.5in length x 71.0in width x 105.0in height

## 2.05 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel powered from the engine generator battery. Include interconnection to energy control center, building BMS, Utility, and PV system.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
1. Ammeter-voltmeter, phase-selector switch(es).
  2. Engine lubricating-oil pressure gauge.
  3. Engine-coolant temperature gauge.
  4. DC voltmeter (alternator battery charging).
  5. Running-time meter.
  6. AC voltmeter, for each phase.
  7. AC ammeter, for each phase.
  8. AC frequency meter.
  9. Generator-voltage adjusting feature
  10. Generator overload.
  11. Start-stop switch.
  12. Overspeed shutdown device.
  13. Coolant high-temperature shutdown device.
  14. Coolant low-level shutdown device.
  15. Oil low-pressure shutdown device.

16. Generator overload.

- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Additional Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."
- F. Common Remote Audible Alarm: send a single trouble alert to fire alarm system if any of the following occur, Include necessary contacts and terminals in control and monitoring panel.
  - 1. Overcrank shutdown.
  - 2. Coolant low-temperature alarm.
  - 3. Control switch not in auto position.
  - 4. Battery-charger malfunction alarm.
  - 5. Battery low-voltage alarm.
- G. Remote Emergency-Stop Switch where required by local Authorities Having Jurisdiction: Red mushroom head type with an engraved label "EMERGENCY STOP SWITCH". Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation with a transparent see-thru lexan cover. Include weatherproof hardware.

2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker (**400A Frame and above**): Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
  - 1. Tripping Characteristics: Field adjustable long-time and short-time delay and instantaneous. Trip unit shall be field replaceable.
  - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
  - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
  - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
  - 5. Enclosure: Provide NEMA 4X stainless steel enclosure for breakers mounted exposed to weather.
- B. Generator Protector (where provided in basis of design equipment indicated on plans): Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
  - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
  - 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
  4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications. Alarm shall be remotely monitored by BMS.

## 2.07 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Per basis shall be per equipment indicated on plans
- B. Comply with NEMA MG 1.
- C. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- D. Electrical Insulation: Class H or Class F.
- E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Drip proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
  1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

## 2.08 LOAD BANK

- A. Description: provide permanent hookup cabinet for connection of portable load bank.

## 2.09 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Basis shall be per equipment indicated on plans.
- B. Each: Level 1A sound attenuation weather-protective enclosure with low profile tank with 20 hour full capacity: 1,001 gallons. Total footprint dimensions with generator: 247.5in length x 71.0in width x 105.0in height
- C. Enclosure Construction: Minimum 14 gauge Steel with hinged, removable doors to allow access to the engine, alternator, and control panel. Adjustable hinges for door alignment. Hinges and all exposed fasteners must be stainless steel. Pop-rivets weaken the paint system and are not allowed on external painted surfaces. Each door equipped with lockable hardware and identical keys.
- D. Upward discharging enclosure ventilation exhaust hood.

- E. Enclosure Finish: Electrostatic applied powder paint, baked and finished to manufacturer's specifications.
- F. Enclosure Color: Manufacturer's standard.
- G. Where applicable, Silencer mounted on top of enclosure.
- H. Heater factory installed within enclosure designed to maintain minimum internal temperature at 40 deg F (4 deg C).
- I. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
- J. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.
- K. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

## 2.10 VIBRATION ISOLATION DEVICES

- A. Provide all integral vibration and isolation components per basis equipment indicated on plans.
- B. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
  - 1. Material: Standard neoprene separated by steel shims.
  - 2. Shore A Scale Durometer Rating: 70.
  - 3. Number of Layers: One.
- C. Restrained Spring Isolators, where required: Freestanding, steel, open-spring isolators with seismic restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Minimum Deflection: 1 inch (25 mm)
- D. Provide vibration isolation and flexible connector materials for steel piping.
- E. Provide vibration isolation and flexible connector materials for exhaust shroud and ductwork.
- F. Vibration isolation devices shall not be used to accommodate misalignments or to make bends



## 2.11 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.
- B. Powder coated paint surfaces:
  - 1. Minimum Paint Thickness: 2.5 mil (0.06 mm) in accordance with ASTM D 1186-87.
  - 2. Material Hardness: ASTM D3363-92a.
  - 3. Resistance to Cracking: ASTM D522-B.
  - 4. Paint Adhesion: ASTM D3359-B.
  - 5. Resistance to Salt Water Corrosion: ASTM B117, ASTM D1654.
  - 6. Resistance to Humidity: ASTM D1735, ASTM D1654.
  - 7. Impact Resistance: ASTM 2784.
  - 8. UV Protection: SAE J1690.

## 2.12 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  - 1. Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
  - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  - 2. Test generator, exciter, and voltage regulator as a unit.
  - 3. Full load run.
  - 4. Maximum power.
  - 5. Voltage regulation.
  - 6. Transient and steady-state governing.
  - 7. Single-step load pickup.
  - 8. Safety shutdown.
  - 9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
  - 10. Report factory test results within 10 days of completion of test.
- C. Report factory test results within 10 days of completion of test.
  - 1. Report shall be reviewed, signed by the factory testing engineer. Include name of the engineer, date and location of testing.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Equipment Mounting:
  - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
  - 3. Install packaged engine generator with elastomeric isolator pads restrained and/or spring isolators having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- D. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
  - 1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
  - 2. Install flexible connectors and steel piping materials in accordance with requirements in Section 232116 "Hydronic Piping Specialties."
  - 3. Insulate muffler/silencer and exhaust system components in accordance with requirements in Section 230719 "HVAC Piping Insulation."
- E. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- F. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases.
- G. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

### 3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Install exhaust-system piping. Extend to point of termination outside structure. Size piping according to manufacturer's written instructions.
  - 1. Where applicable, install condensate drain piping for engine exhaust system. Extend drain piping from low points of exhaust system and from muffler to condensate traps and to point of disposition.
- E. Connect fuel piping to engines with a gate valve and union and flexible connector.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.04 IDENTIFICATION

- A. Identify system components according to Section 260553 "Identification for Electrical Systems."
- B. Install a warning sign at the neutral to ground bond location indicating:
  - 1. "WARNING: SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE IS ENERGIZED."

### 3.05 FIELD QUALITY CONTROL

- A. Provide simultaneous in-field coordination with service representatives for generator controls, PV system, Colton Electrical Utility, Switchboard Manufacturer Energy Control Systems, and Mechanical Building Management System vendor for complete controls.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Tests and Inspections:
  - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
  - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - i. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - ii. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

- iii. Verify acceptance of charge for each element of the battery after discharge.
- iv. Verify that measurements are within manufacturer's specifications.
- 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
- 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
- 6. Exhaust Emissions Test, where required for permitting: Comply with applicable government test criteria.
- 7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
- 8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- 9. Noise Level Tests, where required for permitting: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest as specified above.
- J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

### 3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Training shall be held on site after the generator set is complete and fully functional. Training shall include diesel fuel maintenance and cleaning.

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## SECTION 26 33 23

### CENTRAL BATTERY EQUIPMENT

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes slow-transfer central battery inverters with the following features:

1. Output distribution section.
2. Internal maintenance bypass/isolation switch.
3. External maintenance bypass/isolation switch.
4. Multiple output voltages.
5. Emergency-only circuits.
6. Remote monitoring provisions.

- B. Related Sections:

1. Section 260548 "Vibration and Seismic Controls for Electrical Systems.
2. Section 262813 "Fuses
3. Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

##### 1.03 DEFINITIONS

- A. LCD: Liquid-crystal display.
- B. LED: Light-emitting diode.
- C. THD: Total harmonic distortion.
- D. UPS: Uninterruptible power supply.

##### 1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Central Battery Systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For the following:
  1. Electrical ratings, including the following:
    - i. Capacity to provide power during failure of normal ac.
    - ii. Inverter voltage regulation and THD of output current.
    - iii. Transfer time of transfer switch.
    - iv. Data for specified optional features.
  2. Transfer switch.

3. Inverter.
  4. Batteries.
  5. Battery monitoring.
  6. Battery-cycle warranty monitor.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
  2. Elevation and details of control and indication displays.
  3. Output distribution section.

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that central battery inverter equipment will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - i. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Source quality-control test reports. Submit certified test reports within two (2) weeks of completion of tests.
- C. Field quality-control test reports.
1. Test procedures used.
  2. Test results that comply with requirements.
  3. Submit within two (2) weeks of completion of tests.
- D. Warranty: Special warranty specified in this Section.

#### 1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For central battery inverter equipment to include in emergency, operation, and maintenance manuals.

#### 1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
1. Fuses: One for every 10 of each type and rating, but no fewer than three (3) of each.
  2. Cabinet Ventilation Filters: two complete sets.
  3. One spare circuit board for each critical circuit.

#### 1.09 QUALITY ASSURANCE

- A. If alternate manufacturer of products other than what are specified in this section are submitted, all necessary documents not limited to cut sheets, technical information, test reports from recognized testing labs and factory test reports shall be submitted to the satisfaction of the owner/engineer to ensure quality and conformance to the specifications. Additional testing shall be undertaken if it is concluded by the owner/engineer that the submitted test reports are either insufficient or do not include all tests necessary for product acceptance. The tests shall be conducted by a recognized lab acceptable to the owner/engineer and all tests shall be witnessed by owner's/engineer's personnel. All testing procedures and test results shall be satisfactory to the owner/engineer. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one owner's/engineer's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 10 years experience in the production of Central Battery Systems similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Central Battery Inverter Systems shall be assembled at the manufacturer's own manufacturing facility using its own major components for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Provide certified test reports of shake table test done by manufacturer on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Central Battery Inverter Systems shall be manufactured within six months of installation.
- H. Source Limitations: Obtain Central Battery Inverter Systems, overcurrent protective devices, components, and accessories, within same product category, through one source from a single manufacturer through a local distributor unless otherwise noted. Comply with NFPA 70.
- I. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- J. Product Options: Drawings indicate size, profiles, and dimensional requirements of Central Battery Inverter Systems are based on the specific system indicated. Refer to Part 2 "Product Requirements."
- K. Central Battery Inverter System: UL 924 and UL 1778 listed and labelled.
- L. Comply with NFPA 70 and NFPA 101.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles.
- B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

#### 1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace complete Central Battery Inverter Systems that fail in materials or workmanship within a warranty period of minimum three (3) years. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified. Warranties shall apply from the date of substantial completion.



1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
  - i. Premium, Valve-Regulated, Recombinant, Lead-Calcium Batteries:
    - 1) Full Warranty: One year.
    - 2) Pro Rata: 19 years.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, and meeting the space requirements shown on the drawings:
  1. Myers
  2. IOTA
  3. Cooper Industries, Inc.; Sure-Lites Division.
  4. Dual-Lite.

### **2.02 INVERTER PERFORMANCE REQUIREMENTS**

- A. The inverter shall be fully automatic and include a linear transformer. The inverter output voltage is generated by sinusoidal pulse width modulation (PWM).
- B. Manual and Automatic Testing:
  1. Automatic monthly and annual self-diagnostic test.
  2. Automatically records the last twenty (20) events in the test result log.
  3. Manual user initiated test at any time.
- C. Provide historical data for one year which can be downloaded.
- D. Slow-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use an electromechanical switch to transfer loads. Transfer in one second or less from normal supply to battery-inverter supply.
  1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
- E. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 0.004 second or less from normal supply to battery-inverter supply.
  1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.

### **2.03 SERVICE CONDITIONS**

- A. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  1. Ambient Temperature for Electronic Components: 32 to 98 deg F (0 to 37 deg C).
  2. Relative Humidity: 0 to 95 percent, noncondensing.

3. Altitude: Sea level to 4000 feet (1220 m).

#### 2.04 INVERTERS

A. Description: Solid-state type, with the following operational features:

1. Automatically regulate output voltage to within plus or minus 5 percent.
2. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
3. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
  - i. THD shall not exceed 5 percent when serving a resistive load of 100 percent of unit rating.
4. Output Protection: Output circuit breakers with proper AIC and short-circuit protection based on maximum available fault current. Verify available fault levels from Short Circuit and Coordination Study. Or, system shall include Ferroresonant transformer to provide inherent overload and short-circuit protection.
5. Surge Protection: Auxiliary panel suppressors specified in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
6. Overload Capability: 125 percent for 10 minutes; 150 percent surge.
7. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

#### 2.05 BATTERY CHARGER

- A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

#### 2.06 BATTERIES

- A. Description: Premium, valve-regulated, recombinant, lead-calcium or Standard, valve-regulated, recombinant, lead-calcium batteries.
1. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes at rated voltage during emergency mode.

#### 2.07 ENCLOSURES

- A. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
- B. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.
- C. All components shall have modular design and quick disconnect to facilitate field service.

#### 2.08 SEISMIC REQUIREMENTS

- A. Central battery inverter assemblies, subassemblies, components, fastenings, supports, and mounting and anchorage devices shall be designed and fabricated to withstand seismic forces. The term "withstand" is defined in the "Manufacturer Seismic Qualification Certification" Paragraph in Part 1 "Informational Submittals" Article.

#### 2.09 CONTROL AND INDICATION

- A. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure. All alarms shall be automatically recoded and displayed. The front panel shall include a 2 line 20 character display and key pad for system input. To ensure only authorized persons have access, the system is multilevel password protected for all system functions and parameter changes.

- B. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
- C. Indications: Plain-language messages on a digital LCD or LED.
- D. Dry-form "C" contacts shall be available for remote indication of the following conditions:
  - 1. Inverter in alarm condition, include connection to building fire alarm.
- E. Enclosure: Steel, with hinged pad-lockable doors, suitable for floor mounting. Manufacturer's standard corrosion-resistant finish.

## 2.10 OUTPUT DISTRIBUTION SECTION

- A. Panelboard: Comply with Section 262416 "Panelboards" except provide assembly integral to equipment cabinet.

## 2.11 SYSTEM MONITORING AND ALARMS

- A. Provisions for Remote Computer Monitoring: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in Part 2 "Control and Indication" Article. Remote computer and connecting signal wiring will be provided by Owner. Include the following features:
  - 1. Connectors and network interface units or modems for data transmission via RS-232 link or ethernet.
  - 2. Software shall be designed to control and monitor inverter system functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of reports. Include capability for storage and analysis of power-line transient records. Software shall be compatible with requirements in Section 260913 "Electrical Power Monitoring and Control" and the operating system and configuration of Owner-furnished computers.
- B. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
  - 1. Annunciation of Alarms: At inverter system control panel.
- C. Battery-Cycle Warranty Monitoring: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring charge-discharge cycle history of batteries covered by cycle-life warranty.
  - 1. Basic Functional Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on integral LCD.
  - 2. Additional monitoring functions and features per model indicated on drawings.

## 2.12 SOURCE QUALITY CONTROL

- A. Factory test complete inverter system, including battery, before shipment. Include the following:
  - 1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
  - 2. Full-load test.
  - 3. Transient-load response test.
  - 4. Overload test.
  - 5. Power failure test.

- B. Observation of Test: Give 14 days' advance notice of tests and provide access for Owner's representative to observe tests at Owner's option.
- C. Report test results for client records. Include the following data:
  - 1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
  - 2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.
  - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 INSTALLATION**

- A. Install system components on concrete base and attach by bolting.
  - 1. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548 "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.
  - 2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

#### **3.03 CONNECTIONS**

- A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

#### **3.04 IDENTIFICATION**

- A. Identify equipment and components according to Section 260553 "Identification for Electrical Systems."
- B. Label each cabinet indicating electrical, chemical and fire hazards.

- C. Identify each cabinet indicating manufacturer, model no., serial no., voltage, current rating and date of installation.

### 3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
  - 1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
  - 2. Test manual and automatic operational features and system protective and alarm functions.
  - 3. Test communication of status and alarms to remote monitoring equipment.
  - 4. Perform a 90 minute full load test to verify the functioning of the complete system including batteries after loss of normal power. Verify that all loads on Central Battery System are maintained during the 90 minute test. Test shall be witnessed by owner's representative. Provide 14 days advance notice.
  - 5. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
  - 6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.06 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that central battery inverter is installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
- D. Complete installation and startup checks according to manufacturer's written instructions.

### 3.07 ADJUSTING AND CLEANING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

### 3.08 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters. Refer to Section 017900 "Demonstration and Training." Training shall be held at site after the system is complete and functional.

**END OF SECTION**

## SECTION 26 36 00

### TRANSFER SWITCHES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
  - 1. Automatic transfer switches.
  - 2. Remote annunciation systems.
  - 3. Remote annunciation and control systems.

##### 1.03 DEFINITIONS

- A. ATS: Automatic Transfer Switch
- B. BP/IS: Bypass switch and Isolation Switch
- C. EMI: Electromagnetic interference.
- D. LCD: Liquid-crystal display.
- E. LED: Light-emitting diode.
- F. NETA: InterNational Electrical Testing Association.
- G. PC: Personal computer.
- H. THD: Total harmonic distortion.
- I. UPS: Uninterruptible power supply.

##### 1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Transfer switches shall withstand the effects of earthquake motions determined according to.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

##### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings for construction: .
  - 1. Single-Line Diagram: Show connections between transfer switch, switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

##### 1.06 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification for client record: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

- i. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control test reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.08 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs within 8 hours from the time of notification.
- C. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Emergency/Standby Engine Generators similar to the type and size specified in this project. Furnish a list of three (3) contacts for the three (3) similar projects completed within the last 5 years. Include name, tele no and email of the facility engineers.
- D. Manufacturer shall have ISO 9001 or 9002 Certification.
- E. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- F. Transfer Switch shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., contactors) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- G. Transfer Switch shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer on similar units.

- H. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g. contactors, controls) shall be manufactured within six months of installation.
- I. Source Limitations: Obtain automatic transfer switches, remote annunciator and control panels through one source from a single manufacturer switch, and accessories through one source from a single manufacturer through a local distributor.
- J. Product Options: Drawings indicate size, profiles, and dimensional requirements of engine generators and are based on the specific system indicated. Refer to Part 2 ~~Section 016000~~ "Product Requirements."
- K. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100; and marked for intended location and application.
- L. Comply with NEMA ICS 1.
- M. Comply with NFPA 70.
- N. Comply with NFPA 110.
- O. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.09 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
  - 1. Notify Construction Manager and Owner no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Construction Manager and Owner written permission.

1.10 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

## PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
  - i.
  - ii. Breaker Transfer Switch
  - iii. Square D
  - iv. ASCO Power Technologies, LP.
  - v. Russellectric Inc

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.



- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location. Verify maximum available fault levels from the Short Circuit and Coordination Study.
  2. Short-time withstand capability for 3 cycles.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: motorized breakers.
1. Switch Action: mechanically held .
- G. Service-Rated Transfer Switch:
1. Comply with UL 869A and UL 489.
  2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
  3. In systems with a neutral, the bonding connection shall be on the neutral bus.
  4. Provide removable link for temporary separation of the service and load grounded conductors.
  5. Surge Protective Device: Service rated.
  6. Ground-Fault Protection: Comply with UL 1008 for normal bus.
- H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 260553 "Identification for Electrical Systems."
1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- K. Enclosures: Free standing, general-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
- L. 1. Enclosure shall be fabricated from 12 gauge steel and shall be sized to exceed minimum bending space required by UL 1008. Doors shall have hinges and locking handle latch with provision for padlocks.

- M. 2. Contractors field wiring terminating within the enclosure shall comply with NFPA 70. Wires shall be permanently tagged near the terminal at each end with the wire number shown on approved shop drawings.
- N. 3. The enclosure shall be constructed for convenient removal and replacement of contacts, coils, springs and control devices from the front without removal of main power conductors or removal of major components. The enclosure housing the ATS and BP/IS shall be constructed to protect personnel from energized components of the BO/IS during maintenance of the ATS.

## 2.03 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- E. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- G. Automatic Transfer-Switch Features in combination with energy control center of switchboard and generator control panel:
  - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
  - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  - 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  - 5. Test Switch: Simulate normal-source failure.
  - 6. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  - 7. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

8. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
9. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
  - i. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - ii. Push-button programming control with digital display of settings.
  - iii. Integral battery operation of time switch when normal control power is not available.

#### 2.04 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

- A. Functional Description: Include the following functions for indicated transfer switches and generator controls:
  1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
  2. Indication of switch position.
  3. Indication of switch in test mode.
  4. Indication of failure of digital communication link.
  5. Key-switch or user-code access to control functions of panel.
  6. Control of switch-test initiation.
  7. Control of time-delay bypass for transfer to normal source.
- B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- C. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
  1. Controls and indicating lights grouped together for each transfer switch.
  2. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
  3. Digital Communication Capability: Matched to that of transfer switches supervised.
  4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

#### 2.05 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Annunciator and Control Panel Mounting: surface with cabinet, and local control in switchboard.
- B. Identify components according to Section 260553 "Identification for Electrical Systems."
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

### **3.02 CONNECTIONS**

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### **3.03 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Provide simultaneous in-field coordination with service representatives for generator controls, PV system, Colton Electrical Utility, Switchboard Manufacturer, and Mechanical Building Management System vendor for complete controls.
- C. Manufacturer's Field Service's Tests and Inspections:
  - 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  - 2. Perform each visual and mechanical inspection and electrical test stated in latest edition of NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - i. Check for electrical continuity of circuits and for short circuits.
    - ii. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - iii. Verify that manual transfer warnings are properly placed.
    - iv. Perform manual transfer operation.
  - 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    - i. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    - ii. Simulate loss of phase-to-ground voltage for each phase of normal source.
    - iii. Verify time-delay settings.

- iv. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - v. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
  - vi. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
  - vii. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- i. Verify grounding connections and locations and ratings of sensors.
- D. Coordinate tests with tests of generator and run them concurrently.
- E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- F. Remove and replace malfunctioning units and retest as specified above.

3.04 **DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training." Training shall be held on site after the all transfer switches are completely installed, tested and fully functional.
- B. Coordinate this training with that for generator equipment.

**END OF SECTION**

## SECTION 26 43 13

### SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Requirements:
  - 1. Section 262413 "Switchboards" for factory-installed SPDs.
  - 2. Section 262416 "Panelboards" for factory-installed SPDs.

##### 1.03 DEFINITIONS

- A. I(nominal): Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Product Certificates: For transient voltage surge suppression devices, signed by the product manufacturer certifying compliance with the following standards UL 1449 and UL 1283.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. For client record: Field quality-control reports. Include the following:
  - 1. Test procedures used.
  - 2. Test results that comply with the requirements.

##### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For SPDs to include emergency, operation and maintenance manuals.

1.07 QUALITY ASSURANCE

- A. If alternate manufacturer of products other than what are specified in this section are submitted, all necessary documents not limited to cut sheets, technical information, test reports from recognized testing labs and factory test reports shall be submitted to the satisfaction of the owner/engineer to ensure quality and conformance to the specifications. Additional testing shall be undertaken if it is concluded by the owner/engineer that the submitted test reports are either insufficient or do not include all tests necessary for product acceptance. The tests shall be conducted by a recognized lab acceptable to the owner/engineer and all tests shall be witnessed by owner's/engineer's personnel. All testing procedures and test results shall be satisfactory to the owner/engineer. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one owner's/engineer's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Surge Protective Devices (SPDs) similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Surge Protective Devices (SPDs) shall be assembled at the manufacturer's own manufacturing facility using its own major components (e.g., trip units) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Provide certified test reports of shake table test done by manufacturer on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Controllers shall be manufactured within six months of installation.
- H. Source Limitations: Obtain Surge Protective Devices (SPDs), overcurrent protective devices, components, and accessories, within same product category, through one source from a single manufacturer through a local distributor unless otherwise noted.
- I. Comply with NFPA 70.
- J. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- K. Product Options: Drawings indicate size, profiles, and dimensional requirements of Surge Protective Devices (SPDs) are based on the specific system indicated. Refer to Part 2 "Product Requirements."
- L. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100 and marked for intended location and application.
- M. Testing Agency Qualifications: Member of NETA;
  - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of Surge Protective Devices, OCPDs, switches and breakers similar to those specified on this project.
  - 2. Testing company shall be located with 50 miles radius of the project.
  - 3. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.

4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of Surge Protective Devices (SPDs), OCPDs, switches and circuit breakers similar to the type and rating specified on this project.

#### 1.08 WARRANTY

- A. For client record: Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers
  1. Schneider Electric Industries SAS
  2. Eaton Corporation.
  3. GE Zenith Controls.
  4. Siemens Industry, Inc.

#### 2.02 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449 and 1283
- D. Comply with ANSI/IEEE C62.41-2002 and C62.5-2002
- E. MCOV of the SPD shall be at least 125 percent of the nominal system voltage.

#### 2.03 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSORS

- A. SPDs: Comply with UL 1449, Type 2.
- B. SPD shall be tested with the ANSI/IEEE Category C<sub>High</sub> exposure waveform (20kV-1.2/50 $\mu$ s, 10kA-8/20 $\mu$ s).
- C. Pulse life test: Capable of protecting against and surviving 20,000 ANSI/IEEE Category C<sub>High</sub> transients without failure or degradation of clamping voltage by more than 10%.
- D. Comply with UL 1283.
- E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
  1. Line to Neutral: 1200 V for 480Y/277 and V 700 V for 208Y/120 V.
  2. Line to Ground: 1200 V for 480Y/277 V and 1200 V for 208Y/120 V.
  3. Line to Line: 2000 V for 480Y/277 V and 1000 V for 208Y/120 V.
- G. SCCR: Equal or exceed 200 kA.
- H. I(nominal) Rating: 20 kA.



## 2.04 PANEL SUPPRESSORS

- A. SPDs: Comply with UL 1449, Type 2.
  - 1. Include LED indicator lights for power and protection status.
  - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - 3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
- B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 65 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- C. Comply with UL 1283.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V for 208Y/120 V.
  - 2. Line to Ground: 700 V for 208Y/120 V.
  - 3. Neutral to Ground: 700 V for 208Y/120 V.
  - 4. Line to Line: 1200 V for 208Y/120 V
- E. SCCR: Equal or exceed 65 kA.
- F. I(nominal) Rating: 20 kA.

## 2.05 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.

## 2.06 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

# **PART 3 - EXECUTION**

## 3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:
  - 1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.02 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  2. Inspect anchorage, alignment, grounding, and clearances.
  3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.03 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

**END OF SECTION**

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## SECTION 26 51 19

### LED INTERIOR LIGHTING

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes the following types of LED luminaires as applicable:

1. Cylinder.
2. Downlight.
3. Linear industrial.
4. Lowbay.
5. Recessed, linear.
6. Strip light.
7. Surface mount, linear.
8. Surface mount, nonlinear.
9. Suspended, linear.
10. Suspended, nonlinear.

- B. Related Requirements:

1. Section 260943 Network lighting control systems with low-voltage control wiring or data communication circuits.

##### 1.03 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  1. Arrange in order of luminaire designation.
  2. Include data on features, accessories, and finishes.
  3. Include physical description and dimensions of luminaires.
  4. Include emergency lighting units, including batteries and chargers.
  5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

- i. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- ii. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps, refer to light fixture schedule on plans.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings for construction: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which equipment and luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:
  - i. Other luminaires.
  - ii. Air outlets and inlets.
  - iii. Speakers.
  - iv. Sprinklers.
  - v. Access panels.
  - vi. Ceiling-mounted projectors.
7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Data for client record: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

2. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.08 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

- C. Provide luminaires from a single manufacturer for each luminaire type.

- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

- E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.

2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

- B. Warranty Period: Five year(s) from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.01 REFER TO LIGHT FIXTURE SCHEDULE ON PLANS**

### **2.02 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."
- C. Ambient Temperature: 41 to 104 deg F (5 to 40 deg C).
  - 1. Relative Humidity: Zero to 95 percent.

### **2.03 LUMINAIRE REQUIREMENTS**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. California Title 24 and Title 20 compliant.
- C. Basis of fixtures shall be per fixtures listed on fixture schedule. Proposed alternates be submitted and approved by both architect and EOR prior to ordering. Contractor shall take responsibility to complete photometric studies, title 24 documentation, load analysis for alternates prior to submitting for approval.

### **2.04 LUMINAIRE SUPPORT**

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 TEMPORARY LIGHTING**

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

### 3.03 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and relamping.
  - 3. Provide support for luminaire without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
  - 5. Allow for seismic bracing any pendant fixtures and supports where another obstruction is within 45 degree swing impact: 4 seismic bracings in orientation by 90 degrees of each other. Bracings shall be done with fixture manufacturer's hardware, 0.06" diameter minimum aircraft cable.
- E. Flush-Mounted Luminaires:
  - 1. Secured to outlet box.
  - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
  - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaires:
  - 1. Attached to structural members in walls or Attached to a minimum 20 gauge backing plate attached to wall structural members.
  - 2. Do not attach luminaires directly to gypsum board.
- G. Suspended Luminaires:
  - 1. Ceiling Mount:
    - i. Two 5/32-inch diameter aircraft cable supports adjustable to 10 feet in length.
    - ii. Pendant mount with 5/32-inch diameter aircraft cable supports adjustable to 10 feet in length.
    - iii. Hook mount.
  - 2. Pendants and Rods: Where longer than 24 inches, brace to limit swinging.
  - 3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod wire support for suspension for each unit length of luminaire chassis, including one at each end.
  - 5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- H. Ceiling-Grid-Mounted Luminaires:
  - 1. Secure to any required outlet box.



2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
  3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
- I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.06 STARTUP SERVICE

- A. Comply with requirements for startup specified in lighting control specifications.

3.07 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  3. Adjust the aim of luminaires in the presence of the Architect.

**END OF SECTION**

## SECTION 26 56 19

### LED EXTERIOR LIGHTING

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

###### B. Related Requirements:

1. Section 260943 Programmable lighting control systems with low-voltage control wiring or data communication circuits.

##### 1.03 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

##### 1.04 ACTION SUBMITTALS

###### A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project and testing procedures and criteria required by IES LM-79 and LM-80.
  - i. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
  - ii. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
  7. Photoelectric relays.
  8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
  2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring.
- C. Sustainable Design Submittals:
1. "BUG ratings" Light Pollution Reduction for both uplight and light trespass.
- 1.05 PRODUCT DATA: INDICATING LUMINAIRE IS CERTIFIED BY.
- A. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- B. Delegated-Design Submittal: For luminaire supports.
1. Include design calculations for luminaire supports and seismic restraints.
- 1.06 INFORMATIONAL SUBMITTALS
- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
  2. Structural members to which equipment and luminaires will be attached.
  3. Underground utilities and structures.
  4. Existing underground utilities and structures.
  5. Above-grade utilities and structures.
  6. Existing above-grade utilities and structures.
  7. Building features.
  8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
1. Luminaire.
  2. Photoelectric relay.
- E. Test reports complying with LM-79 (IES approved method for electrical and photometric measurements of Solid-State Lighting) providing total luminous flux, luminous intensity

distribution, electrical power characteristics, luminous efficacy and color characteristics (CRI, CCT) shall be submitted. Test reports complying with LM-80 (IES approved standard for measuring lumen maintenance of LED light sources) providing lumen maintenance of LED light sources shall be submitted.

- F. ISTMT (IN SITU TEMPERATURE MEASUREMENT TEST) – It is the measure of the LED source case temperature within the LED system (luminaire or lamp or it is the temperature of the LED within the luminaire. This measurement should be performed according to the temperature measurement point (TMP) indicated by the particular LED package manufacturer. The temperature measured within the luminaire shall be within the temperature of the LM-80-08 LED source report.
- G. All LED lifetime projections shall be made per TM-21-11 (approved method for taking LM-80 data and making useful LED lifetime projections).
- H. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency as follows:
  - 1. Test reports complying with LM-79 (IES approved method for electrical and photometric measurements of Solid-State Lighting) providing total luminous flux, luminous intensity distribution, electrical power characteristics, luminous efficacy and color characteristics (CRI, CCT) shall be submitted.
  - 2. Test reports complying with LM-80 (IES approved standard for measuring lumen maintenance of LED light sources) providing lumen maintenance of LED light sources shall be submitted.
  - 3. ISTMT (IN SITU TEMPERATURE MEASUREMENT TEST) – It is the measure of the LED source case temperature within the LED system (luminaire or lamp or it is the temperature of the LED within the luminaire. This measurement should be performed according to the temperature measurement point (TMP) indicated by the particular LED package manufacturer. The temperature measured within the luminaire shall be within the temperature of the LM-80-08 LED source report.
  - 4. All LED lifetime projections shall be made per TM-21-11 (approved method for taking LM-80 data and making useful LED lifetime projections).
- I. Source quality-control reports.

#### 1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
  - 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

#### 1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

#### 1.09 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- F. Mockups: For exterior luminaires, complete with power and control connections.
  - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
  - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

#### 1.11 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

#### 1.12 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - i. Structural failures, including luminaire support components.
    - ii. Faulty operation of luminaires and accessories.
    - iii. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Period: 5-years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

### **2.02 LUMINAIRE REQUIREMENTS**

- A. Basis shall be per fixtures on fixture schedule.

### **2.03 LUMINAIRE SUPPORT COMPONENTS**

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 TEMPORARY LIGHTING**

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

### **3.03 GENERAL INSTALLATION REQUIREMENTS**

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and relamping.
  - 3. Support luminaires without causing deflection of finished surface.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or Attached to a minimum 1/8 inch backing plate attached to wall structural members.
  - G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
  - H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.
  - I. Coordinate layout and installation of luminaires with other construction.
  - J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
  - K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.
- 3.04 BOLLARD LUMINAIRE INSTALLATION:
- A. Align units for optimum directional alignment of light distribution.
    1. Install on concrete base with flush at finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."
- 3.05 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES
- A. Aim as indicated on Drawings.
  - B. Install on concrete base with at finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."
- 3.06 CORROSION PREVENTION
- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
  - B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.
- 3.07 IDENTIFICATION
- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- 3.08 FIELD QUALITY CONTROL
- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
  - B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
    1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
    2. Verify operation of photoelectric controls.
  - C. Illumination Tests:
    1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.
    2. Coordinate "Operational Test" Subparagraph below with requirements in Section 260923 "Lighting Control Devices."

3. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.09 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.10 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  3. Adjust the aim of luminaires in the presence of the Architect.

**END OF SECTION**



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## SECTION 28 46 21.11

### ADDRESSABLE FIRE-ALARM SYSTEMS

#### **PART 1 - GENERAL**

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

###### A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Device guards.
7. Magnetic door holders.
8. Remote annunciator.
9. Addressable interface device.
10. Digital alarm communicator transmitter.
11. Network communications.

##### 1.03 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
  1. Include construction details, material descriptions, dimensions, profiles, and finishes.
  2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
  1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
  2. Include plans, elevations, sections, details, and attachments to other work.
  3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.

4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
  - i. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
  - ii. Show field wiring required for HVAC unit shutdown on alarm.
  - iii. Locate detectors according to manufacturer's written recommendations.
13. Include alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
  - i. Trained and certified by manufacturer in fire-alarm system design.
  - ii. NICET-certified, fire-alarm technician; Level III minimum.
  - iii. Licensed or certified by authorities having jurisdiction.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Data: Certificates, for fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.06 SAMPLE WARRANTY: FOR SPECIAL WARRANTY.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

- i. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- ii. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
- iii. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
- iv. Riser diagram.
- v. Device addresses.
- vi. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
- vii. Record copy of site-specific software.
- viii. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
  - 1) Equipment tested.
  - 2) Frequency of testing of installed components.
  - 3) Frequency of inspection of installed components.
  - 4) Requirements and recommendations related to results of maintenance.
  - 5) Manufacturer's user training manuals.
- ix. Manufacturer's required maintenance related to system warranty requirements.
- x. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Programming, recommissioning, and training to County security services; including programming for graphical interface systems.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.09 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II minimum technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.10 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
  1. Notify Construction Manager and Owner no fewer than 14 days in advance of proposed interruption of fire-alarm service.
  2. Do not proceed with interruption of fire-alarm service without Construction Manager's and Owner's written permission.
- C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.
- C. Provide fire watch during all shutdowns with pre-approved plan for operations with County

1.12 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
  1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.

2. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.01 SYSTEM DESCRIPTION**

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of: Honeywell. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### **2.02 SYSTEMS OPERATIONAL DESCRIPTION**

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
  1. Manual stations.
  2. Heat detectors.
  3. Smoke detectors.
  4. Duct smoke detectors.
  5. Automatic sprinkler system water flow.
  6. Fire-extinguishing system operation.
- B. Fire-alarm signal shall initiate the following actions:
  1. Continuously operate alarm notification appliances, including voice evacuation notices.
  2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
  3. Transmit an alarm signal to the remote alarm receiving station.
  4. Unlock electric door locks in designated egress paths.
  5. Release fire and smoke doors held open by magnetic door holders.
  6. Activate alarm communication system.
  7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
  8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
  9. Recall elevators to primary or alternate recall floors.
  10. Activate elevator power shunt trip.
  11. Activate emergency lighting control.
  12. Record events in the system memory.
  13. Record events by the system printer.

14. Indicate device in alarm on the graphic annunciator.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
  2. Elevator shunt-trip supervision.
  3. User disabling of zones or individual devices.
  4. Loss of communication with any panel on the network.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
  2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
  4. Loss of primary power at fire-alarm control unit.
  5. Ground or a single break in internal circuits of fire-alarm control unit.
  6. Abnormal ac voltage at fire-alarm control unit.
  7. Break in standby battery circuitry.
  8. Failure of battery charging.
  9. Abnormal position of any switch at fire-alarm control unit or annunciator.
- E. System Supervisory Signal Actions:
1. Initiate notification appliances.
  2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
  3. Record the event on system printer.
  4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
  5. Transmit system status to building management system.
  6. Display system status on graphic annunciator.

## 2.03 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 2.04 FIRE-ALARM CONTROL UNIT

- A. General Requirements for Fire-Alarm Control Unit: **(Silent Knight)**
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
    - i. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.

- ii. Include a real-time clock for time annotation of events on the event recorder and printer.
  - iii. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
  - iv. The FACP shall be listed for connection to a central-station signaling system service.
  - v. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
- 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
- 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
  - 1. Annunciator and Display: Liquid-crystal type, 40-80 characters, minimum.
  - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
  - 1. Annunciator and Display: Liquid-crystal type, three line(s) of 40-80 characters, minimum.
  - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
  - 1. Pathway Class Designations: NFPA 72, Class B.
  - 2. Pathway Survivability: Level 1.
  - 3. Serial Interfaces:
    - i. One dedicated RS 485 port for remote station operation using point ID DACT.
    - ii. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
    - iii. One USB or RS 232 port for PC configuration.
    - iv. One RS 232 port for VESDA HLI connection.
    - v. One RS 232 port for voice evacuation interface.
- E. Smoke-Alarm Verification:



1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
  2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
  3. Record events by the system printer.
  4. Sound general alarm if the alarm is verified.
  5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- F. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
  2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- G. Elevator Recall:
1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
    - i. Elevator lobby detectors except the lobby detector on the designated floor.
    - ii. Smoke detector in elevator machine room.
    - iii. Smoke detectors in elevator hoistway.
  2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
  3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
    - i. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
- H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.
- I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also, print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- L. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

- M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
  - 1. Batteries: Sealed lead calcium or Sealed, valve-regulated, recombinant lead acid or Vented, wet-cell pocket, plate nickel cadmium.
- N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

## 2.05 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
  - 1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  - 2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  - 3. Station Reset: Key- or wrench-operated switch.
  - 4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

## 2.06 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
  - 1. Comply with UL 268; operating at 24-V dc, nominal.
  - 2. Detectors shall allow for four or two-wire type.
  - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
  - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  - 6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
  - 7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
    - i. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
    - ii. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).

- iii. Multiple levels of detection sensitivity for each sensor.
- iv. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - i. Primary status.
  - ii. Device type.
  - iii. Present average value.
  - iv. Present sensitivity selected.
  - v. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - i. Primary status.
  - ii. Device type.
  - iii. Present average value.
  - iv. Present sensitivity selected.
  - v. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

## 2.07 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).

1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.08 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
- B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
  1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
  1. Rated Light Output:
    - i. 15/30/75/110 cd, selectable in the field.
  2. Mounting: Wall mounted unless otherwise indicated.
  3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  4. Flashing shall be in a temporal pattern, synchronized with other units.
  5. Strobe Leads: Factory connected to screw terminals.

## 2.09 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
  2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  3. Rating: 24-V ac or dc.
  4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

## 2.10 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
  1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

## 2.11 ADDRESSABLE INTERFACE DEVICE

### A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

### B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

### C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

### D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

## 2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

### A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

### B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

### C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

### D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.

- 8. Communication bus failure.
  - E. Secondary Power: Integral rechargeable battery and automatic charger.
  - F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
- 2.13 NETWORK COMMUNICATIONS
- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
  - B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.
  - C. Provide integration gateway using BACnet for connection to building automation system.
- 2.14 DEVICE GUARDS
- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
    - 1. Factory fabricated and furnished by device manufacturer.
    - 2. Finish: Paint of color to match the protected device.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 EQUIPMENT INSTALLATION**

- A. Comply with NFPA 72, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
  - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
  - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
  - 1. Connect new equipment to existing control panel in existing part of the building.
  - 2. Connect new equipment to existing monitoring equipment at the supervising station.
  - 3. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

- C. Equipment Mounting: Install fire-alarm control unit on concrete base.
1. Install seismic bracing. Comply with requirements in Section 270548.16 "Seismic Controls for Communications Systems."
  2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (460-mm) centers around the full perimeter of concrete base.
  3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."
- E. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
  2. Mount manual fire-alarm box on a background of a contrasting color.
  3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- F. Smoke- or Heat-Detector Spacing:
1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
  2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
  3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
  4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
  5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
  6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- G. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

- I. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- K. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.
- M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

### 3.03 PATHWAYS

- A. Pathways shall be installed in EMT.
- B. Exposed EMT shall be painted red enamel.

### 3.04 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
  - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
  - 2. Smoke dampers in air ducts of designated HVAC duct systems.
  - 3. Magnetically held-open doors.
  - 4. Electronically locked doors and access gates.
  - 5. Alarm-initiating connection to elevator recall system and components.
  - 6. Alarm-initiating connection to activate emergency lighting control.
  - 7. Supervisory connections at valve supervisory switches.
  - 8. Supervisory connections at elevator shunt-trip breaker.
  - 9. Data communication circuits for connection to building management system.

### 3.05 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

### 3.06 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.



### 3.07 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - i. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    - ii. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
  - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
  - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
  - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
  - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

### 3.08 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.09 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

**END OF SECTION**

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## SECTION 31 10 00

### SITE CLEARING

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

###### A. Section Includes:

1. Removal of vegetation, grass, grass roots, shrubs, tree stumps, trees, upturned stumps, weed growth, tree roots, brush, masonry, concrete, rubbish, debris and other materials.
2. Removal of concrete and bituminous surfaces.
3. Removal of existing fences and gates.

###### B. Related Requirements:

1. Division 01 – General Requirements.
2. Section 31 22 00 – Grading.
3. Section 31 23 13 – Excavation and Fill.
4. Section 31 23 16 – Excavation and Fill for Pavement.
5. Section 31 23 26 – Base Course.
6. Section 32 31 13 – Chain Link Fences and Gates

##### 1.02 SUBMITTALS

- A. Shop Drawings: Submit site plan indicating extent of site clearing.

##### 1.03 QUALITY ASSURANCE

- A. Comply with Standard Specifications for Public Works Construction, current edition, as a minimum requirement.

#### **PART 2 – PRODUCTS**

NOT USED

#### **PART 3 - EXECUTION**

##### 3.01 TREE AND STUMP REMOVAL

- A. Remove trees and stumps indicated or required to be removed. Remove trees, together with bulk of roots, to a minimum depth of 4 feet below required grade, and within a radius of approximately 7 feet beyond perimeter of trunk at grade.
- B. Fill and compact excavation from tree and stump removal. Fill in 6 inch layers, each compacted to 90 percent of maximum density in accordance with ASTM D1557.
1. Back filling shall not commence until the excavation is inspected and tested.

##### 3.02 CONCRETE AND BITUMINOUS SURFACING REMOVAL

- A. Break up and completely remove existing concrete surfacing, curbs, gutters, walks and bituminous surfacing to indicated limits. Cutting shall be performed to a neat and even

line with proper tools or a concrete cutting saw. Minimum depth of cut shall be 1 1/2-inch, unless otherwise indicated. Remove concrete broken beyond the indicated limits to the nearest joint or score line and replace with new concrete to match existing.

3.03 FENCING

- A. Existing fences scheduled to remain may be removed to facilitate the Work, provided they are installed to their original condition in accordance with requirements of Section 32 3113 - Chain Link Fences and Gates.
- B. Fencing indicated to be removed and not reinstalled shall be completely removed, including footings. Fill and compact excavations.
- C. Install chain link fencing indicated to be relocated or reset in accordance with applicable requirements specified under Section 32 3113 - Chain Link Fences and Gates.

3.04 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

**END OF SECTION**

## SECTION 31 22 00

### GRADING

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

A. Section Includes:

1. General exterior grading, cutting and filling, including grading for building area, paving, planting areas, banks and hillsides.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 31 10 00 - Site Clearing.
3. Section 31 23 13 - Excavation and Fill.
4. Section 31 23 16 - Excavation and Fill for Pavement.
5. Section 31 23 26 - Base Course.

##### 1.02 PROJECT REQUIREMENTS

A. General:

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.
4. Before grading, contact Underground Service Alert of Southern California (USASC) for information on public buried utilities and pipelines. Retain the services of an underground utility locator for on-site utilities.

#### **PART 2 - PRODUCTS**

##### 2.01 MATERIALS

- A. Materials shall conform to requirements specified in this and related sections.

#### **PART 3 - EXECUTION**

##### 3.01 PREPARATION

- A. Protect and maintain installed stakes until their removal is required for the Work. Provide replacement grade or location stakes lost or disturbed.
- B. Install grade stakes and compare to indicated grades. If discrepancies are found between existing grades and grades indicated on Drawings, do not proceed until discrepancies are resolved.

##### 3.02 ROUGH AND FINE GRADING

- A. Rough grade area sufficiently high to require cutting by fine grading:

1. Grade area for bituminous surfacing and other paving to the indicated grades, equal to the section of the indicated base and pavement.
  2. Slope banks to required finish grades as cut progresses or leave cuts full and finish grade by mechanical equipment to provide grades and soil densities indicated on the Drawings.
  3. Rough grade, fill and compact banks beyond indicated finish grades. Finish grade banks and slopes to indicated grades and specified soil densities.
  4. Grade Only Areas: In areas not indicated to receive pavement, rough grade to approximate finish grades and then scarify, moisten and roll to obtain required density and indicated finish grades.
  5. Tolerances: Finish grades shall be within a tolerance of 0.05 inch per foot above or below grades indicated. Provide an average grade as indicated.
- B. Base or Subgrade:
1. After subgrade has been constructed to approximate required grades, scarify to a depth of at least 6 inches:
    - a. After scarifying, process loosened material to a finely divided condition and adjust moisture content to optimum condition by addition of water, addition and blending of dry suitable material, or by drying of existing material.
    - b. Subgrade material shall be compacted by tamping, sheepsfoot rollers or pneumatic tire rollers. Required relative compaction shall be 90 percent minimum for the top 6 inches below subgrade.
    - c. Install base course in accordance with Section 31 2326 - Base Course.
  2. Tolerance of completed grades of base or subgrade shall not vary more than 0.03 inch per foot from grades indicated. Provide an average grade as indicated.

### 3.03 SHORING

- A. Provide shoring as necessary to properly and safely support earth sides of excavations, and existing curbs, sidewalks, gutter, drives and stairs, against movement and collapse.
- B. Design and Calculations: Provide in accordance with requirement of CalOHSA.
- C. Remove shoring upon completion of the Work of this section or when no longer needed unless required otherwise by authorities having jurisdiction.

### 3.04 EXCESS MATERIAL DISPOSAL

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

### 3.05 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

**END OF SECTION**

## SECTION 31 2313

### EXCAVATION AND FILL

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

###### A. Section Includes:

1. Excavating, filling, backfilling, and compacting for Project site pavement, planting areas, buildings, and other structures.
2. Trenches for utility lines such as water, gas, irrigation, storm drain and sewer lines, concrete-encased conduits, manholes, vaults, valve boxes, catch basins, underground tanks, thrust blocks, yard boxes, pull boxes, and other utility appurtenances.

###### B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 01 45 24 - Environmental Import/Export Materials Testing.
3. Section 31 10 00 - Site Clearing.
4. Section 31 22 00 - Grading.
5. Section 31 23 26 - Base Course.
6. Section 32 13 13 - Site Concrete Work.

##### 1.02 PROJECT REQUIREMENTS

###### A. Import and Export of Earth Materials:

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

##### 1.03 SUBMITTALS

###### A. Shoring calculations as required in Article 3.03 of this Section.

##### 1.04 QUALITY ASSURANCE

- A. Comply with the Standard Specifications for Public Works Construction, current edition, except as modified herein.
- B. Sampling, testing, and certification of imported and exported soils shall be performed in accordance with Section 01 4524, Environmental Import/Export Materials Testing.

##### 1.05 TESTING

- A. OWNER will retain a Geotechnical Engineer as an OWNER Consultant who will provide observations, tests, inspections and approvals identified in the Contract Documents as being responsibility of OWNER.
- B. Imported Soils: The Geotechnical Engineer will obtain initial product Sample for testing in accordance Article 3.05 of this Section.

##### 1.06 PROJECT CONDITIONS



- A. Information on Drawings or in soil investigation report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.

## **PART 2 - PRODUCTS**

### **2.01 FILL AND BACKFILL MATERIALS**

- A. Fill and backfill material shall be a granular material previously removed from excavation or imported fill material, free of clods and stones larger than 3 inches, (2½ inches for utility trenches) foreign materials, vegetable growths, sod, expansive soils, rubbish and debris. Material shall conform to these specified requirements and related sections.
- B. Fill material exhibiting a wide variation in consistency and moisture content shall be blended and aerated to stabilize and upgrade the material.
- C. Bedding material from trench bottom to one foot above the pipe:
1. Sand, gravel, crushed aggregate or native free-draining granular material providing a sand equivalent of at least 30 or a coefficient of permeability greater than 1.4 inches per hour.
  2. Sand complying with the Specifications for cement concrete aggregates.
- D. Brick rubble and broken concrete originating from the Project site shall be legally disposed of off the Project site. No such material shall be imported from outside the Project site.
- E. Permeable Backfill:
1. Provide permeable backfill material behind retaining structures consisting of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combinations of these materials conforming to the following gradations:

<u>Sieve Size:</u>	<u>Percentage Passing:</u>
3/4 inch (19mm)	100
3/8 inch (10mm)	80 to 100
No. 100	0 to 8
No. 200	0 to 3
  2. Those portions of fill material passing a No. 4 sieve shall provide a sand equivalent of at least 60.
  3. Provided backing for weep-holes shall consist of two cubic feet of aggregate in burlap sacks, securely tied. Aggregate shall conform to requirements for No. 3 concrete aggregate as specified in subsection 200-1.4 of the Standard Specifications for Public Works Construction.
  4. Permeable Backfill Alternate Materials: Instead of the materials specified for retaining structures backfill, a drainage matting system Miradrain by Mirafi, Inc., American Wick Drain, JDR Enterprises, or equal, may be provided if reviewed and approved by the ARCHITECT.
- F. Cement-sand slurry shall be provided with one sack of cement per cubic yard of the mixture.

### **2.02 BASE MATERIALS**

- A. Concrete Slabs on Grade: Provide "Crushed Aggregate Base" as specified in Standard Specifications for Public Works Construction, Section 200 - Rock Materials, with 3/4 inch maximum size aggregates. Provide 3 inch thick base, unless noted otherwise.

- B. Bituminous Surfacing: Provide as indicated on Drawings and specified in Section 31 2326 Base Course.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. Before initiating intrusive activities, contact Underground Service Alert of Southern California (USA or Dig Alert) to obtain a Dig Alert ticket for location information on buried public and USA member utilities and pipelines at least 48-hours prior to beginning work. A copy of the Dig Alert ticket shall be forwarded to the OWNER. For on-site utilities, retain a state-licensed third party underground utility locating service.
- B. Where the Work includes a building extension or addition on an occupied Project site, perform Work in such a manner, and at such times, as not to disrupt performance of existing utility services to existing Project site facilities. Where an interruption is necessary, obtain review from the Owner's Authorized Representative before proceeding.
- C. Remove concrete or bituminous pavement to straight lines by saw cutting.

#### **3.02 PROTECTION**

- A. Protect and guard excavations against danger to life, limb, and property as required by, but not limited to, OSHA regulations.
- B. Protect existing improvements including landscaping against damage. Repair or replace damaged items.
- C. Protect existing utility services and distribution systems from damage or displacement.
- D. Remove conduits or pipes not in service, exposed during Work, unless a minimum cover of two feet is provided. Remove concrete, clay or other non-metallic pipe over 8 inches in diameter, unless otherwise indicated.
- E. Shore, crib, or lag excavations and earthen banks as necessary to prevent cave in, erosion or gullying of sides.
- F. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. If soil becomes soft, soggy, or saturated, excavate to firm undisturbed earth and fill as required. Slope adjacent grades away from excavations to minimize entry of water.

#### **3.03 SHORING**

- A. Provide shoring as necessary to properly and safely support earth sides of excavations, and existing curbs, sidewalks, gutter, drives and stairs, against movement and collapse.
- B. Design and Calculations: Provide in accordance with requirement of governing Cal-OSHA requirements.
- C. Remove shoring upon completion of the Work of this Section or when no longer needed unless required otherwise by authorities having jurisdiction.

#### **3.04 EXCAVATION**

- A. Unclassified Excavations: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork", except as modified herein.
- B. Form sides of footings, pads, grade beams, and slab foundations, unless otherwise indicated. Provide excavations of sufficient size to permit installation and removal of forms and other required Work.

- C. Machine-drill excavation for round footings to size and depth indicated. Provide a collar or casing, or other adequate protection, to exclude dirt and debris. Protect excavations with plank covers until concrete is placed.
- D. Provide excavation bottoms level and free from loose material. Excavate to indicated or required elevations of undisturbed earth.
- E. Barricade trenches, ditches, pits, sumps, and similar Work outside the barricaded working area with chain link fence as specified in Section 01 5000 - Construction Facilities and Temporary Controls, and in accord with Cal-OSHA standards and requirements.
- F. Trenches over five feet in depth shall comply with the Construction Safety Orders of the California Division of Industrial Safety.
- G. Where indicated or required to excavate in lawn areas, protect adjoining lawn areas outside of the Work area. Replace or install removed sod upon completion of backfill by installing sod level with adjacent lawns. If installation of removed sod fails, furnish sod and install to match existing lawns.

### 3.05 IMPORT/EXPORT OF MATERIALS

- A. Unclassified Fill and Compaction: Comply with the Standard Specifications for Public Works Construction, Section 300 - Earthwork, except as modified herein. Install and compact fill in layers not to exceed 6 inches in thickness.
- B. Provide fill materials as specified in Part 2- Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.
- C. In addition to the requirements of this Section, import and/or exported materials shall comply with the requirements of Section 01 4524, Environmental Import/Export Materials Testing.
- D. Imported fill materials shall be sampled by the Geotechnical Engineer, for compliance with the requirements of Part 2 of this Section.
- E. Initial sampling and testing shall be performed before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and entity responsible for the source site. The Geotechnical Engineer, will obtain both the initial and additional samples from the identified site and submit samples for required testing.
- F. The Geotechnical Engineer will perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1000 cubic yards of material, one sample shall be obtained and submitted for testing for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.
- G. The independent approved testing laboratory will perform the required tests and report results of tests noting if the tested material passed or failed such tests and will furnish copies to the Project Inspector, ARCHITECT, Owner's Authorized Representative, CONTRACTOR, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents and California Building Code.
- H. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.

- I. Upon completion of import operations, provide the Owner's Authorized Representative a certification statement attesting that imported material has been obtained from the identified source site.

### 3.06 INSTALLATION OF MATERIALS

- A. Pavement: Fill or backfill materials shall be installed in horizontal layers of 6 inches, unless otherwise required. Each layer shall be evenly placed and moistened or aerated as necessary. Unless otherwise reviewed by the Geotechnical Engineer, each layer of fill material shall cover the length and width of the area to be filled before the next layer of material is installed. Top surface of each layer shall be installed to an approximate level with a crown or crossfall of at least 1 in 50, but not more than 1 in 20. Provide adequate drainage at all times during installation of the Work of this Section.

### 3.07 COMPACTING

- A. Each layer of fill material shall be compacted by tamping, sheepfoot rollers, or pneumatic-tired rollers to provide specified relative compaction. At inaccessible locations, provide specified compaction by manually held, operated and directed compaction equipment.
- B. Install and compact sand bedding to provide a uniform bearing under the full length of piping and conduits.
- C. Unless otherwise indicated, compact each layer of fill material to a relative compaction of at least ninety percent.
- D. When fill materials, or a combination of fill materials, are encountered or provided which develop densely packed surfaces as a result of installation or compacting operations, scarify each layer of compacted fill before installing the next succeeding layer.

### 3.08 INSPECTION AND TESTING

- A. The Geotechnical Engineer will inspect and test excavations, sample material quality for testing as set required in Part 2, and observe installation and compaction of fill materials.
- B. The Geotechnical Engineer will sample imported fill materials from their designated source and submit samples to the independent approved testing laboratory before delivery to the Project site.
- C. Installation of backfill shall be observed by the Geotechnical Engineer.
- D. The Geotechnical Engineer will inspect and test excavation Work before the installation of fill and other materials.
- E. Compaction: Test compaction in accordance with ASTM D1557, Method C.
- F. The Project Inspector will inspect foundation excavations when completed and ready for forms, after forms are in place, and before first placement of concrete.

### 3.09 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

### 3.10 CLEANING

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**END OF SECTION**

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## SECTION 31 23 16

### EXCAVATION AND FILL FOR PAVING

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Excavating, backfill, and compacting for paved areas.
  - 2. Installation of fill materials.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 31 10 00 - Site Clearing.
  - 3. Section 31 22 00 - Grading.
  - 4. Section 32 23 26 - Base Course.
  - 5. Section 32 12 16 - Asphalt Paving.
  - 6. Section 32 13 13 - Site Concrete Work.

##### 1.02 PROJECT REQUIREMENTS

- A. Import and Export of Earth Materials:
  - 1. Fees: Pay as required by authorities having jurisdiction over the area.
  - 2. Bonds: Post as required by authorities having jurisdiction over the area.
  - 3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

##### 1.03 QUALITY ASSURANCE

- A. Comply with Standard Specifications for Public Works Construction, current edition, except as modified herein.
- B. Sampling, testing, and certification of imported and/or exported soils shall be performed in accordance with Section 01 4524 - Environmental Import/Export Materials Testing.

##### 1.04 TESTING

- A. OWNER will retain a Geotechnical Engineer as an OWNER Consultant who will provide observations, tests, inspections and approvals identified in the Contract Documents as being responsibility of OWNER.
- B. Imported Soils: The Geotechnical Engineer will obtain initial product Sample for testing in accordance Article 3.05 of this Section.

##### 1.05 PROJECT CONDITIONS

- A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.

#### **PART 2 - PRODUCTS**

##### 2.01 BASE MATERIALS

- A. Concrete Slabs On Grade: Provide "Crushed Aggregate Base "as specified in the Standard Specifications for Public Works Construction, Section 200: "Rock Materials," with ¾ inch maximum size aggregates. Provide 3-inch thick base, unless noted otherwise.
- B. Bituminous Surfacing: As indicated on Drawings and specified in Section 31 2326 - Base Course.

## 2.02 FILL AND BACKFILL MATERIALS

- A. Fill and backfill materials shall be previously excavated materials or imported fill material, free of clods and stones larger than 3-inch, foreign materials, vegetable growths, sod, expansive soils, rubbish and debris. Material shall conform to these specified requirements and related sections.
- B. Fill material exhibiting a wide variation in consistency and moisture content shall be blended or aerated to stabilize and upgrade the material.
- C. Imported Fill Material:
  - 1. Provide suitable materials obtained from Project site excavations for earthwork and fill materials. If excavated materials are not of suitable quality or sufficient quantity, import additional materials as necessary.
  - 2. Imported fill shall be a granular material with sufficient binder to form a firm and stable unyielding subgrade and shall not have more than 60 percent of fines passing 200 mesh sieve. Material shall have a coefficient of expansion of not more than 2 percent from air dry to optimum moisture content and not more than 6 percent from air dry to saturation. Imported material shall be clean and free of rubbish, debris, and toxic or hazardous contaminants. Adobe or clay soils are not permitted.
- D. Brick rubble and broken concrete originating from the Project site shall be legally disposed of off the Project site. No such materials shall be imported from outside the Project site.
- E. Permeable Backfill:
  - 1. Provide permeable backfill material behind retaining structures consisting of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combinations of these materials conforming to the following gradations:
 

Sieve Size:	Percentage Passing:
¾ inch (19mm)	100
⅜ inch (10mm)	80 to 100
No. 100	0 to 8
No. 200	0 to 3
  - 2. Those portions of fill material passing a No. 4 sieve shall provide a sand equivalent of at least 60.
  - 3. Provided backing for weep holes shall consist of two cubic feet of aggregate in burlap sacks, securely tied. Aggregate shall conform to requirements for No. 3 concrete aggregate as specified in subsection 200-1.4 of the Standard Specifications for Public Works Construction.
  - 4. Permeable Backfill Alternate Materials: Instead of the materials specified for retaining structures backfill, a drainage matting system, Miradrain by Mirafi, Inc., or equal, may be provided if reviewed and approved by the ARCHITECT.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Before initiating intrusive activities, contact Underground Service Alert of Southern California (USA or Dig Alert) to obtain a Dig Alert ticket for location information on buried public and USA member utilities and pipelines at least 48-hours prior to beginning work. A copy of the Dig Alert ticket shall be forwarded to the OWNER. For on-site utilities, retain a state-licensed third party underground utility locating service.
- B. Clear the Project site as indicated in Section 31 1000 - Site Clearing.

### **3.02 PROTECTION**

- A. Protect and guard excavations against danger to life, limb, and property as required by, but not limited to, Cal-OSHA regulations.
- B. Protect adjacent existing improvements including landscaping against damage.

### **3.03 EXISTING UTILITY LINES**

- A. Protect existing utility lines from damage or displacement.
- B. Remove conduits or pipes not in service, exposed during Work, unless a minimum cover of 2 feet is provided. Remove concrete, clay or other non-metallic pipe over 8 inches in diameter, unless otherwise indicated.

### **3.04 EXCAVATION**

- A. Unclassified Excavations: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork," except as modified herein.

### **3.05 FILL**

- A. Unclassified Fill and Compaction: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork," except as modified herein.
- B. Provide fill materials as specified in Part 2 - Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.
- C. In addition to the requirements of this Section, import and/or exported materials shall comply with the requirements of Section 01 4524 - Environmental Import/Export Materials Testing.
- D. Imported fill materials will be sampled by the Geotechnical Engineer for compliance with the requirements of Part 2 of this Section.
- E. Initial sampling will be performed by the Geotechnical Engineer before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and/or entity responsible for the source site. The Geotechnical Engineer will obtain both the initial and additional samples from the identified site and will submit samples to the approved independent testing laboratory for testing.
- F. The Geotechnical Engineer will perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1,000 cubic yards of material, one sample shall be obtained and submitted for testing for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1,000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.
- G. The independent approved testing laboratory will perform the required tests and report results of tests noting if the tested material passed or failed such tests and will furnish copies to the Project Inspector, ARCHITECT, Owner's Authorized Representative,



CONTRACTOR, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents and CBC.

- H. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.
- I. Upon completion of import operations, provide the Owner's Authorized Representative a certification statement attesting that imported material has been obtained from the identified source site.

### 3.06 INSTALLATION OF MATERIALS

- A. Fill or backfill materials shall be installed in horizontal layers of 6 inches, unless otherwise required. Each layer shall be evenly placed and moistened or aerated as necessary. Unless otherwise reviewed by the Geotechnical Engineer, each layer of fill material shall cover the length and width of the area to be filled before the next layer of material is installed. Top surface of each layer shall be installed to an approximate level with a crown or crossfall of at least 1 in 50, but no more than 1 in 20. Provide adequate drainage at all times during construction of the Work of this Section.

### 3.07 COMPACTING

- A. Each layer of fill material shall be compacted by tamping, sheepfoot rollers, or pneumatic-tired rollers to provide specified relative compaction. At inaccessible locations, provide specified compaction by manually held, operated and directed compaction equipment.
- B. Unless otherwise indicated, compact each layer of earth fill to a relative compaction of at least 90 percent.
- C. When fill materials, or a combination of fill materials, are encountered or provided which develop densely packed surfaces as a result of installation or compacting operations, scarify each compacted layer before installing the next succeeding layer.

### 3.08 INSPECTION AND TESTING

- A. The Geotechnical Engineer will inspect and test excavations, sample material quality as required in Part 2, and observe installation and compaction of fill materials.
- B. The Geotechnical Engineer will sample imported fill materials from their designated source before delivery to the Project site.
- C. Installation of backfill will be observed by the Geotechnical Engineer.
- D. The Geotechnical Engineer will inspect and test excavation Work before the installation of fill and/or other materials.
- E. Compaction: Test compaction in accordance with ASTM D1557, Method C.

### 3.09 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

### 3.10 CLEANING

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**END OF SECTION**

## SECTION 31 23 26

### BASE COURSE

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Installation of base material.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 31 10 00 - Site Clearing.
  - 3. Section 31 22 00 - Grading.
  - 4. Section 31 23 13 - Excavation and Fill.
  - 5. Section 31 23 16 - Excavation and Fill for Paving.
  - 6. Section 32 12 16 - Asphalt Paving.
  - 7. Section 32 13 13 - Site Concrete Work.

##### 1.02 SUBMITTALS

- A. Crushed aggregate base (CAB) shall consist of native rock without naturally occurring asbestos or recycled materials. The CONTRACTOR shall submit written documentation, which identifies the source, volume, and proposed transport date of the material for review and approval by OWNER'S Office of Environmental Health and Safety (OEHS) prior to importing the material. A statement on company letterhead from the CAB source, stamped by either a California Professional Geologist or Engineer, which states that the subject materials are native rock, do not contain any recycled materials and that the source quarry does not mine ultramafic materials, a source of natural occurring asbestos shall be included in the submittal to OEHS. The CONTRACTOR may request variance from analytical testing required by Section 01 4524 for CAB. To be considered for a variance, the CONTRACTOR shall submit a documentation package for OEHS approval, which includes all of the aforementioned information at least 48 hours in advance of planned import.
  - 1. Frequently used suppliers for San Bernardino County projects include:
    - a. Hansen Aggregates.
    - b. Vulcan Materials, Reliance Company.
    - c. Vulcan Materials Durbin.
- C. Product Data: Submit material source, technical information and test data for base materials. Gradation and quality certifications shall be dated within 30 days of the submittal.
- D. Sample: Submit sample of proposed base course material.

##### 1.03 QUALITY ASSURANCE

- A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction, current edition.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

- A. Crushed Aggregate Base (CAB) materials shall conform to the requirements of the Standard Specifications for Public Works Construction: Section 200 - Rock Materials.
- B. Crushed Miscellaneous Base (CMB) or materials generated on site shall not be used as a base course material.

### **2.02 MATERIAL APPROVAL**

- A. Base material shall be inspected by the Project Inspector for gradation and material content prior to installation. The OWNER may choose to have additional tests performed by a geotechnical engineer, retained by the OWNER, before installation.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Install base course material in layers not exceeding 4 inches in thickness, unless required otherwise. Grade and compact to indicated levels or grades, cut and fill, water and roll until the surface is hard and true to line, grade and required section. Provide a relative compaction of at least 95 percent, unless otherwise required.
- B. Grade base course to elevations indicated on Drawings, ready to receive surfacing, in accordance with Section 31 2200 - Grading.

### **3.02 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

### **3.03 CLEANUP**

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**END OF SECTION**

## **SECTION 32 12 16**

### **ASPHALT PAVING**

#### **PART 1 - GENERAL**

##### **1.01 SUMMARY**

A. Section Includes:

1. Paving for playground, parking areas, areas between buildings, synthetic track surfacing adjacent to planting and turf areas as indicated.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 31 22 00 - Grading.
3. Section 32 01 17 - Pavement Repair.
4. Section 31 23 26 - Base Course.
5. Section 32 12 36 - Seal for Bituminous Surfacing.
6. Section 32 13 13 - Site Concrete Work.

##### **1.02 SUBMITTALS**

- A. Shop Drawings: Submit site plan indicating extent of paving and accessories.
- B. Product Data: Manufacturer's technical data for materials and products.

##### **1.03 QUALITY ASSURANCE**

- A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction.

##### **1.04 PROJECT CONDITIONS**

- A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.
- B. A copy of the soils report is available for examination in the office of the Architect during regular office hours of the Architect.

#### **PART 2 - PRODUCTS**

##### **2.01 BITUMINOUS MATERIALS**

- A. Provide materials of the class, grade, or type indicated on the Drawings, conforming to relevant provisions of Section 203 - Bituminous Materials of the Standard Specifications for Public Works Construction.

#### **PART 3 - EXECUTION**

##### **3.01 CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT**

- A. Thickness of Surfacing: Unless otherwise indicated on Drawings or specified, install bituminous surfacing to a compacted thickness of 2 inches.

- B. Provide surfacing material over base course as specified in Section 31 2326 - Base Course.
- C. Surfaces of walls, concrete, masonry, or existing bituminous surfacing indicated to be in direct contact with installed bituminous surfacing shall be cleaned, dried and uniformly coated with an asphaltic emulsion film.
- D. Thicken edges of bituminous surfacing that do not abut walls, concrete, or masonry, and edges joining existing bituminous surfaces. Remove headers at existing bituminous surfacing where new bituminous surfacing is to be installed. Thicken edges an additional 2 inches and taper to the indicated or specified thickness 6 inches back from such edges.
- E. At stairways, adjust thickness of paving such that the first tread is equal in height to all other treads.
- F. Provide adequate protection for concrete, planting areas, and other finish Work adjacent to areas indicated to receive bituminous surfacing.
- G. Placing:
1. Do not install bituminous surfacing when atmospheric temperature is below 40 degrees F; or when fog or other unsuitable weather conditions are present. Temperature of mixture at time of installation shall not be lower than 260 degrees F in warm weather or higher than 320 degrees F in cold weather.
  2. Where 2-inch or 3-inch thick surfacing is indicated or specified, install surfacing in one course. Where surfacing is indicated or specified 4 inches or more in thickness, except for thickened edges, install bituminous surfacing in courses of approximately equal thickness, each course not exceeding 2 ½ inches in thickness.
- H. Stakes or Screeds: Provide grade or screed stakes spaced not more than 15 feet apart in flow lines with grades of less than one percent. Continuous screeds may be provided instead of stakes.
- I. Spreading: Install bituminous surfacing in a manner to cause least possible handling of mixture. In open areas and wherever practicable, install by mechanical means with a self-propelled mechanical spreader. In confined or restricted areas, install mixture with hot shovels and rakes, and smooth with lutes.
- J. Joints: Provide vertical joints between successive runs. Install joints true to line, grade, and cross section. Lapped joints are not permitted.
- K. Rolling:
1. Finish roll with a self-propelled tandem roller weighing at least 8 tons. Break down roll with a self-propelled roller weighing between 1 ½ tons and 8 tons.
  2. Roll in a manner that preserves flow lines and the established finished grades. Break down roll in areas adjacent to flow lines parallel to flow lines. Break down roll after bituminous surfacing is installed without shoving or cracking of mixture under roller. Continue finish rolling until surfacing is unyielding, true to grade, and meets requirements for specified smoothness. Areas inaccessible to finish roller may be finish rolled with breakdown roller or tamped with hot tamping irons and smoothed with hot smoothing irons or hand roller.
  3. Where bituminous surfacing abuts concrete, masonry, walks or paving, tamp joint smooth, if necessary, as described above to obtain a uniformly even joint, true to line and grade. Tamp and smooth to properly compact.
  4. Compacted bituminous surfacing shall be provided with a bulk specific gravity of at least 2.31 when tested in accordance with ASTM D1188.

### 3.02 TOLERANCE

- A. Smoothness: Surface of bituminous surfacing after rolling, shall be even, smooth and uniform in texture with no voids or rock pockets, free of roller marks or other irregularities, and not varying by more than 0.03 foot, except at local depressions or raised areas as indicated, when a 10-foot straightedge is placed on surface.
- B. Grade: Finished grade shall not vary more than 0.02 foot above or below required grade. Variations within prescribed tolerance shall be compensating so that average grade and cross-section are provided.
- C. Premium paving tolerances:
  - 1. General: Test in-place asphalt concrete courses for compliance with requirements or thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Owner's representative.
  - 2. Thickness: Tolerances for thickness shall be ¼ inch, plus or minus.
  - 3. Planarity: The asphalt substrate shall not vary from the planned cross slope by more than plus or minus 0.1 percent. The finished asphalt shall not vary, plus or minus, under a 10 feet straight edge greater than 1/8 inch. Flood test the surface with the use of a water truck. If, after 30 minutes on a 70 degree F day, "bird baths" are evident at a depth more than 1/8 inch repair using the best method of correction.
  - 4. Corrective Measures: Determine if the planarity, cross slopes, and general specifications have been met. If all of the conditions have been met notify the Owner in writing of the acceptance of the asphalt paving.

### 3.03 TESTING

- A. After first coat of surface seal has been installed and after a 24 hour period, the flood test shall be completed of the bituminous surfacing in presence of the Project Inspector. Repair areas of standing water or puddles and flood test locally; install surface seal and retest as necessary.

### 3.04 SURFACE SEALING

- A. After bituminous surfacing has passed flood test, clear and allow to dry and provide one more coat of surface seal as specified in Section 32 1236 - Seal for Bituminous Surfacing.
- B. Where indicated, provide multiple coats of surface seal to existing bituminous surfacing.
- C. Where new bituminous surfacing joins existing bituminous surfacing, overlap surface seal a minimum of 12 inches onto existing bituminous surfacing.

### 3.05 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

### 3.06 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

**END OF SECTION**

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## SECTION 32 12 36

### SEAL FOR BITUMINOUS SURFACING

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Surface sealer over bituminous surfacing.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 32 01 17 - Pavement Repair.
  - 3. Section 32 12 16 - Asphalt Paving.

##### 1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product information and application procedures for bituminous surfacing.

##### 1.03 QUALITY ASSURANCE

- A. Comply with the Standard Specifications For Public Works Construction, current edition.
- B. Agitate bulk materials during transport.

##### 1.04 MAINTENANCE

- A. Extra Materials: Provide 10 gallons in unopened containers.

#### **PART 2 - PRODUCTS**

##### 2.01 MATERIALS

- A. Provide one of the following surface seals:

<u>Product Name</u>	<u>Manufacturer</u>
1. Guard-Top	CALMAT / Industrial Asphalt
2. Over Kote	Diversified Asphalt Product
3. Park Top	Western Colloid Products
4. Sure Seal	Asphalt Coating Engineering
5. Super Drive Top.	SAF- T Seal. Inc.
6. Equal.	

#### **PART 3 - EXECUTION**

##### 3.01 SURFACE PREPARATION

- A. Thoroughly wash surfaces with water to remove dirt, debris, excessive oil and grease, or other foreign matter.



### 3.02 APPLICATION

- A. Install seal coat in strict accordance with manufacturer's written directions and recommendations.
- B. Install two coats of surface seal to new bituminous surfacing. First coat shall be installed before flood testing. Clean surface and allow to dry before installing second coat. Second coat shall be installed after bituminous surfacing has passed flood test.
- C. Where new bituminous surfacing is installed adjacent to existing bituminous surfacing, overlap surface seal a minimum of 12 inches onto existing bituminous surfacing.
- D. Where existing bituminous surfacing is indicated to be patched and sealed, install two coats of surface seal after patching. Refer to Section 32 1216 - Asphalt Paving.

### 3.03 PROTECTION OF SURFACES

- A. Protect sealed and unsealed surfaces from damage and traffic during performance of the Work of this section and until surface seal has thoroughly set and cured. Do not permit traffic of any kind for at least 24 hours after completion of installation.
- B. Protect the Work of this section until Substantial Completion.

### 3.04 TESTING

- A. Owner reserves the right to obtain samples, perform tests to ensure compliance with the Specifications, and to review weight slips and invoices of materials delivered to the Project site.

### 3.05 CLEAN UP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**END OF SECTION**

## SECTION 32 13 13

### SITE CONCRETE WORK

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

A. Section Includes:

1. Portland cement concrete pavement, cement walks, curbs, gutters, trash pick-up area, ramps, mowing strips, fence post footings, sliding gate concrete tracks, catch basins, pipe bedding and encasements, thrust blocks, transition structures, flagpoles and light standard bases and footings, athletic equipment footings and equipment pads.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 31 22 00 - Grading.
3. Section 31 23 13 - Excavation and Fill.
4. Section 31 23 16 - Excavation and Fill for Pavement.
5. Section 31 23 26 - Base Course.
6. Section 32 12 16 - Asphalt Paving

##### 1.02 SUBMITTALS

- A. Shop Drawings: Submit plans, elevations and details of concrete site Work.
- B. Product Data: Submit mix designs and manufacturer's technical data for materials and products. Submit 3-inch by 3-inch concrete Sample of each specified color.
- C. Material Sample: Submit one concrete bumper to the Project Inspector for destructive testing.

##### 1.03 QUALITY ASSURANCE

- A. Comply with Standard Specifications For Public Works Construction.

#### **PART 2 - PRODUCTS**

##### 2.01 MATERIALS

- A. Concrete, Mortar and Related Materials: Comply with applicable provisions of Standard Specifications for Public Works Construction, Section 201 - Concrete, Mortar and Related Materials:

1. Concrete: 28-day compressive strength 2,500 psi, unless specified otherwise.
2. Reinforcing Mesh: ASTM A185, 4 by 4/W1.4 by W1.4 welded wire mesh.
3. Expansion Joint Filler: Preformed expansion joint filler, bituminous type, complying with ASTM D994.

B. Form Materials:

1. Side forms: Douglas fir, Construction Grade or Better or metal forms.
2. Stakes: Douglas fir, Construction Grade or Better or metal stakes.

- C. Concrete Parking Bumpers:
1. Precast concrete, smooth and free of pits and rock pockets, providing a minimum 28-day compressive strength of 3,500 psi. Size at least 7 ½-inch wide, 5 ½-inch high and 6-foot long. Reinforce with two #5 reinforcing bars. Provide 2 ¾-inch diameter pre-drilled holes for anchor installation.
  2. Bumper Anchors: Provide ½ inch diameter by 18-inch long galvanized steel pipe.
  3. Bumper Adhesive: Provide adhesive recommended by bumper manufacturer/installer for fastening bumpers to concrete pavement.

### **PART 3 - EXECUTION**

#### **3.01 CONSTRUCTION OF FORMS FOR CAST-IN-PLACE STRUCTURES**

- A. Concrete Pavement: Install Portland cement concrete pavement in compliance with the Standard Specifications for Public Works Construction, Section 302- Roadway Surfacing.
- B. Miscellaneous Exposed Concrete: Install concrete curbs, walks, gutters, cross gutters, access ramps, driveways, catch basins, yard boxes, vaults and similar structures, in compliance with the Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction.
- C. Exposed Concrete Bases: Install bases, such as for post, flagpole, light standards and similar bases, in compliance with the Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction.
- D. Post, flagpole, light standard footings below grade, underground conduit bedding, encasements, thrust blocks and similar structures may be placed directly in excavations conforming to the required sizes.
- E. Reinforcement installation and concrete placement, surface finishes, curing and removal of forms shall be performed in compliance with applicable provisions of Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction. Provide heavy broom finish at slopes exceeding six percent and medium broom finish at slopes up to six percent.

#### **3.02 INSTALLATION OF PARKING BUMPERS**

- A. Install bumpers as indicated on the Drawings. On bituminous paving, install anchors through pavement and into the ground a minimum of 12 inches. On concrete pavement, install bumpers in a continuous bed of adhesive.

#### **3.03 CLEAN UP**

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

#### **3.04 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

**END OF SECTION**

## SECTION 32 15 40

### DECOMPOSED GRANITE SURFACING

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

###### A. Section Includes:

1. Naturally occurring decomposed granite and crushed stone surfacing as shown on Drawings and specified herein. Include sub-grade, edging and related accessories.

###### B. Related Sections:

1. Section 31 22 19 "Finish Grading".

##### 1.03 STANDARDS AND REFERENCES

- A. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- B. ASTM D448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction.

##### 1.04 QUALITY ASSURANCE

- A. Comply with Section 01 40 00.
- B. Manufacturer: Company specializing in manufacturing Work of this Section with minimum 25 years documented experience.
- C. Single Source Responsibility: Obtain each type of decomposed granite surfacing from single manufacturer.
- D. Mock Up: Provide a mock-up for evaluation of surface preparation, installation techniques and quality of application.
  1. Install a 4-feet x 4-feet minimum of decomposed granite surfacing, including subbase course and edging, at location approved by Landscape Architect.
  2. Do not proceed with remaining work until installation of decomposed granite surfacing is approved by Landscape Architect.
  3. Approved mock-up may remain as part of completed Work.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00.

##### 1.06 SUBMITTALS

- A. Comply with Section 01 33 00.
- B. Shop Drawings: Submit plan layout of all decomposed granite surfacing areas and detail drawings showing the various components of the surfacing system, including subbase and edging.
- C. Product Data: Manufacturer's literature completely describing all components of the decomposed granite surfacing system, including:

1. Preparation instructions and recommendations.
  2. Installation methods and application procedures.
- D. Samples for Verification:
1. Submit samples of each of the following:
    - a. Three pound sample of each type and color of decomposed granite surfacing material.
    - b. Optional: Edging material, each type not less than 12 inches long.
- E. Certification:
1. Manufacturer and Installer Qualifications.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01 60 00.
- B. Bagged Materials: Accept delivery of materials only in unopened and undamaged containers bearing the brand name and manufacturer's identification.
- C. Bulk Materials: Each load of decomposed granite surfacing material arriving at the job site in bulk shall be accompanied by a delivery ticket containing the following minimum information:
  1. Quarry of origin.
  2. Amount, weight and type of material.
  3. Brand name and manufacturer's identification.
- D. Protect decomposed granite surface surfacing materials from contamination until ready for installation. Store under cover.

#### 1.08 PROJECT CONDITIONS

- A. Surfaces to receive decomposed granite surfacing shall be frost free and free of oil or any other foreign matter, which may impair the proper installation of the surfacing system.
- B. Do not install decomposed granite surfacing when subbase course is muddy or saturated with standing water.
- C. Perform work in dry weather when subgrade is sufficiently stable to be properly compacted.

#### 1.9 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.

### **PART 2 – PRODUCTS**

#### 2.01 MANUFACTURER

- A. Basis of Design Manufacturer: Provide "Standard Pathway Mix" decomposed granite surfacing system by the following: Kafka Granite, LLC. Address: 550 East Hwy 153, Mosinee, WI 54455, Tel: (800) 852-7415 (Toll Free), Fax: (715) 687-2395. Email: [kafka@kafkagranite.com](mailto:kafka@kafkagranite.com) Web: [www.kafkagranite.com](http://www.kafkagranite.com)
- B. Or Architect approved

#### 2.02 DECOMPOSED GRANITE SURFACING MATERIALS

- A. Decomposed Granite and Crushed Stone Aggregate: Provide high quality materials

consisting of sound, angular, durable stone particles, free from clay lumps, organic materials, frozen materials, or other deleterious substances.

- B. Gradation: Manufacturer's standard mix of well-graded materials in accordance with ASTM C136. Blends of coarse sand and rock dust are not acceptable.

Standard Pathway Optimal Gradation		
Sieve	Sieve Size (mm)	Percent Passing
3/8"	9.51	100%
#4	4.76	80-100%
#8	2.36	65-90%
#16	1.18	40-60%
#30	0.6	25-55%
#50	0.3	15-35%
#100	0.149	10-20%
#200	0.074	7-15%

### 2.03 SUBBASE COURSE MATERIALS

- A. Comply with MTO OPSS 1010 – "Material Specification for Aggregates – Granular A, B, M and Select Subgrade Material" specification for Granular A material.
1. Road Base Material: Also known as road rock, road gravel, aggregate base, AB, asphalt base and 3/4" minus. In California the standard is set by Cal Trans and most common is 3/4" aggregate base Class 2.

### 2.04 ACCESSORIES

- A. Water: Clean and potable, free from contaminants that would be deleterious to the decomposed granite surfacing.
- B. Steel Edging: 3/16-inch thick x 4-inch deep with overlapping joints.
1. Stakes: 3/16-inch x 16-inch long x 1 3/4-inch wide at top tapering to point at bottom; locate at 36-inch on center maximum.
- C. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Application of the herbicide shall pose no short or long term health threats to the installer or the general public.

## **PART 3 – EXECUTION**

### 3.01 EXAMINATION

- A. Examine areas and conditions under which Work of this Section will be performed. Notify Landscape Architect of unsatisfactory preparation before proceeding.
- B. Correct conditions detrimental to timely and proper completion of Work.
- C. Do not proceed until unsatisfactory conditions are corrected.

- D. Lay out work prior to the commencement of installation.

### 3.02 PREPARATION

- A. Excavation: Excavate to depth required so edges of decomposed granite surfacing will match adjacent grades and have a maximum cross-slope of 2 percent. Ensure edges and bottom of excavation are in a smooth and even line.
- B. Subgrade Preparation: Plow, harrow and mix the entire surface of the in-place subgrade to a depth of at least 6-inches. After the material has been thoroughly mixed, the subgrade shall be brought to line and grade and compacted to 95% of the maximum laboratory dry density as determined by the Standard Proctor test.
- C. Herbicide: Apply herbicide per manufacturer's written instructions. Limit the application to the area to receive decomposed granite surfacing.
- D. Subbase Course Preparation: Place the subbase coarse aggregate free from ridges, depressions or hollows. Rake and compact to 95% Standard Proctor Density.

### 3.03 INSTALLATION

- A. Steel Edging: Install edging flush with the top of the decomposed granite surfacing. Provide sufficient stakes to secure edging in place during and after decomposed granite surfacing material installation.
- B. Subgrade: Proof-roll the subgrade with heavy pneumatic-tired equipment to locate unstable areas and to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Landscape Architect, and replace with compacted backfill or fill as directed.
  - 2. The surface of the completed subgrade shall be bladed to a smooth and uniform texture.
  - 3. The finished subgrade shall be uniform and free from deleterious debris such as organic materials, nails, stones and loose soil.
- C. Subbase: Install aggregate subbase to a compacted depth of 4 to 6-inches minimum for pedestrian traffic, and 8 to 12-inches minimum for vehicular traffic in accordance with manufacturer's recommendations. Install the subbase in multiple 3 to 4-inch lifts, and compact to a minimum 95% density.
- D. Compaction: Compact each lift of the subgrade, subbase and final finish decomposed granite surfacing materials with a one to three-ton roller or compactor. In small areas that are difficult to access with compaction equipment, hand tamping may be performed with multiple passes to achieve the required density.
  - 1. Lightly spray surface area following compaction. Do not disturb aggregate surface with spray action.

### 3.04 INSTALLATION OF DECOMPOSED GRANITE SURFACING

- A. Spread decomposed granite surfacing material in 3 to 4-inch lifts. Spread the pathway mix evenly and smoothly before compacting. Allow for 20-25% compaction. Scream if possible.
- B. Wet the mix to ensure water has penetrated the full depth of the decomposed granite surfacing material, and roll each lift to form a uniform, smooth surface with a cross slope of 2% maximum. Compact each lift to a minimum 95% density.
- C. Grade and smooth to the required elevation; compact final lift with 1-3 ton drum roller or

compactor.

D. Minimum Compacted Thickness:

1. Pedestrian Paths: 3-inches.
2. Vehicular Drives and Roadways: 4-inches.

E. Surface shall follow grades per plans. Remove crown, allow 1-2% cross pitch.

F. Completed surface shall be of consistent quality and shall not have depressions or humps greater than 1/4-inch in 10-feet.

3.05 INSTALLATION TOLERANCES

A. Decomposed Granite Surfacing Thickness: Allow for 20-25% compaction.

1. Subbase Course: Plus or minus 1/2-inch.
2. Surface Course: Plus 1/4-inch, no minus.

B. Decomposed Granite Surfacing Smoothness: Produce a surface smoothness within 1/4-inch tolerance when measured with a 10-foot straightedge.

1. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowed variance from template is 1/4-inch.

3.06 CLEAN-UP AND PROTECTION

A. Thoroughly clean all areas where work has occurred. Remove from site excess material, debris and rubbish.

B. Take all precautions necessary to protect completed work until Substantial Completion of project.

**END OF SECTION**



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## SECTION 32 17 23.13

### PAINTED PAVEMENT MARKINGS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SUMMARY

Section includes Painted traffic striping and symbols on pavements and curbs.

##### 1.03 REGULATORY REQUIREMENTS

Provide pavement markings meeting the accessibility requirements of the current California Building Code (CBC).

##### 1.04 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00.

##### 1.05 SUBMITTALS

Provide in accordance with Section 01 33 00.

##### 1.06 PRODUCT HANDLING

A. Comply with the requirements of Section 01 66 00.

B. Deliver paints and paint materials in original sealed containers that plainly show the designated name, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage facilities at the project site for maintaining materials at temperatures recommended by the manufacturer.

##### 1.07 ENVIRONMENTAL CONDITIONS

Do not apply paint when either air or pavement temperature is below 50 degrees F or above 95 degrees F; or when rain, fog, condensation, or temperatures below 50 degrees F are anticipated during the drying period.

#### **PART 2 – PRODUCTS**

##### 2.01 MATERIALS

- A. Pavement Marking Paint: Vinyl acrylic type for use on asphaltic concrete and portland cement concrete, colors as indicated, specified herein, or required by CBC Title 24 Part 2.
- B. Acceptable product or Architect approved equal: Dunn-Edwards Paints Vin-L-Stripe Zone Marking Paint.

#### **PART 3 – EXECUTION**

##### 3.01 INSPECTION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that specified items may be installed in accordance with the approved design.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

### 3.02 PREPARATION

- A. Immediately before applying the paint, thoroughly clean the pavement surface of dust, dirt, sand, scale, water, oil, grease or other objectionable matter. Do not use solvent material that will damage pavements as cleaning agents. Immediately before painting, give pavement surfaces a final cleaning by means of a power broom and a power blower using compressed air following the brooming.
- B. Provide warning devices required to protect the painting operations and the finished work.

### 3.03 APPLICATION

- A. Do not apply pavement markings until after sealer has been applied as specified in Section 03 35 00. Apply the paint only when the pavement is dry and clean. Under inclement weather conditions, or when temperature is below 50 degrees F, painting will not be permitted.
- B. Equipment: Apply the traffic and parking striping [and game markings] with a traffic stripe painting machine with a compressor capacity of at least 105 cubic feet and capable of operating at an air pressure of 125 psi. Mechanically agitate paint while the machine is in operation. Equip the striping machine with a pointer so designed that the machine will hold exactly to the alignment. Equip the propelling vehicle with a speedometer or tachometer, and with a suitable device for determining the quantity of paint in the container. Thoroughly clean the paint container and spray nozzles on the machine before starting each day's work.
  - 1. Equipment used for applying reflectorized striping shall be equipped with a bead dispenser capable of applying the beads at the specified rate.
  - 2. Where the configuration or location of a traffic stripe is such that a striping machine is not suitable, use hand spraying equipment and stencils or templates.
  - 3. Apply paint for word markings, letters, numerals, and symbols using hand spraying equipment and stencils or templates.
- C. Application: Immediately following the preparation of the pavement surface, apply the striping at the rate of 100 to 110 square feet per gallon of paint. Apply lines 4 inches wide unless otherwise indicated. Apply the stripe of the indicated or specified width, with clean true edges and without sharp breaks. Repaint, to the applicable specifications, portions of the stripe damaged by any type of traffic within 24 hours after the stripe has been applied.
  - 1. Provide International Symbol of Accessibility for each parking stall for the disabled at location indicated. Symbol shall be 36 inches square, white on standard blue background and shall conform to CBC Title 24 Part 2, Chapter 11; and ADA Accessibility Guidelines for Buildings and Facilities.
  - 2. Tactile warning lines shall be in conformance with CBC Section 1133B.8.3 and 1133B.8.4.
- D. Tolerances: Apply striping within a tolerance of 1/2 inch in 50 feet. Apply markings and stripings to the widths indicated within a tolerance of 1/4 inch on straight sections and 1/2 inch on curved sections.
- E. At completion touch up stripes and markings which are not clear and distinct or which are not uniform in color.

**END OF SECTION**

## SECTION 32 17 26

### TACTILE WARNING SURFACING

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Requirements apply to this Section.

##### 1.02 SUMMARY

- A. Perform all work required to complete, as indicated by the Contract Documents and furnish all supplementary items necessary for the proper installation of Precast Concrete Pavers.
- B. System shall consist of precast concrete pavers installed on Latex thinset mortar setting bed.
- C. The paver installation shall be absolutely rigid and even large slabs when subjected to vehicular traffic, shall not be displaced.

##### 1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
  - 1. ASTM C 33: Specification for Concrete Aggregates
  - 2. ASTM C 150: Specification for Portland Cement
  - 3. ASTM C 67: Method of Sampling and Testing Brick and Structural Clay Tile
  - 4. ASTM C 140: Specification for concrete
- B. T.C.A. Tile Council of America
  - 1. Installation Method Cement Mortar Bonded F102 - 95.
- C. A.N.S.I. American National Standards Institute
  - 1. A-118.4 Latex Portland Cement Mortar
  - 2. A-118.6 Grout – Latex

##### 1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
  - 1. All products covered under this Section shall be produced by a single manufacturer unless otherwise specified.
  - 2. Manufacturer shall submit evidence of having not less than ten (10) years successful production of this product.
  - 3. The paver manufacturer shall demonstrate, either by proven field performance of the laboratory freeze-thaw test that the paving units have adequate durability if they are to be subjected to a freeze-thaw environment.
    - a. Satisfactory field performance is indicated when units similar in composition and made with the same manufacturing process as those to be supplied to the purchaser, do not exhibit objectionable deterioration after at least 3 years.
    - b. The units used as the basis for proven field performance shall have been exposed to the same general type of environment, temperature range and traffic volume as is contemplated for the units supplied to the purchaser.

- B. Subcontractor Qualifications: Subcontractor shall submit evidence of skill and not less than five (5) years specialized experience with this product.

1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00.

1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00.
- B. Manufacturer's Literature: Materials descriptive literature, installation instructions and paver color selection chart.
1. Test Reports: Three (3) copies, showing compliance with specified ASTM requirements
  2. Quality Assurance Qualifications – see Item 1.04.
  3. Shop drawings:
    - a. Layout drawings of each paved area showing the pattern of pavers, indicate pavers requiring cutting, indicate setting bed methods in each area, drainage patterns and drains. Include details of setting beds, noting all materials and their thickness, show details at curbs and vertical surfaces.
    - b. Details of custom (nonstandard) curbs and stair tread/risers, include methods of installation
  4. Samples: Three (3) sample pavers of each manufacturer, type, size and color selected or specified.

1.07 PROJECT/SITE CONDITION

- A. Environmental Requirements: Do no work during freezing weather or on wet or frozen sub-base.
- B. Mock-up Installation
1. Prior to the start of precast concrete paver work construct mock-ups of each type of paver size and pattern area including precast curb for the Owner and Architect to review. The mock-ups will be at the project site at a location mutually agreed to by the Owner and Contractor.
  2. Construct the two (2) mock-up installations a minimum 8 foot x 8 foot area of typical precast concrete units and slabs with all setting beds, joints, edge and curb details as shown on the drawings.
  3. After review of the mock-ups, they should be retained and used as a standard of quality for the precast concrete paver work. At completion of the work remove the mock-up installations and related materials from the project site. If the mock-ups are incorporated in the actual construction, record their actual locations and sizes on the actual built record drawings for the project.

1.08 SEQUENCING AND SCHEDULING

Coordinate sequencing and scheduling of work with other supporting, adjacent, contiguous or otherwise related material trades.

1.09 PRODUCT HANDLING

Adhere to requirements of Section 01 66 00.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. Basis of Design: Tectura Designs, Wausau WI, Phone: 1-800-388-8728.  
Website: <http://www.tecturadesigns.com/products/pavers/detectable-warning-ada-pavers>
- B. System Name: Thinset Mortar Method - Pedestrian Installation
- C. Precast Concrete Pavers
  - 1. Name: Detectable Warning Pavers
  - 2. Size: As shown on the drawings
  - 3. Texture: ADA-2 Truncated Dome
  - 4. Finish and Color: To be picked from Standard color and finish.
  - 5. Reference Standard:
    - a. Cementitious Materials: Materials shall conform to the following applicable ASTM Specifications
      - 1) Portland Cement: ASTM C 150 for Portland Cement
    - b. Aggregates shall conform to these ASTM specifications, except that grading requirements shall not necessarily apply:
      - 1) Normal Weight: ASTM C 33 for Concrete Aggregates
    - c. Other constituents: Coloring pigments, integral water repellents, etc., shall be previously established as suitable for use in concrete and either shall conform to ASTM Standards where applicable, or shall be shown by test or experience not to be detrimental to the durability of the concrete.
  - 6. Performance Requirements:
    - a. Compressive Strength: At the time of delivery to the work site, the average compressive strength shall not be less than 7,000 psi with no individual unit less than 6,500 psi per ASTM C 140.
    - b. Absorption: The average shall not be greater than 5% per ASTM C140.
    - c. Flexural Strength: Not less than 600 psi per ASTM 293.
    - d. Load carrying capacity: Paver units shall have a tested center load capacity of 1,750 lbs.
    - e. Latex Mortar Mix: A.N.S.I A-118.4
    - f. Water: Clean and free of deleterious acids, alkalis or organic materials
    - g. Grout: A.N.S.I. A-118.6, Grout – Latex
    - h. Sealant: As specified in Section 07 90 00.
    - i. Back-up: As specified in Section 07 90 00.
    - j. Bond Breaker: As specified in Section 07 90 00.

### **2.02 MIXING**

- A. Latex Portland Cement Mortar setting bed: As recommended by the manufacturer.
- B. Grouting Mix: Latex as recommended by manufacturer. Color as selected.
- C. Rework mixes from time to time to maintain proper consistency, as recommended by manufacturer but do not add ingredients. Discard mortar that has reached its initial set.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Verify that specified items may be installed in accordance with the approved design.
- C. Correct conditions detrimental to timely and proper completion of the Work.
- D. Do not proceed until unsatisfactory conditions are corrected.
- E. Beginning of installation means acceptance of conditions.

### **3.02 INSPECTION**

- A. Examine all surfaces to receive the parts of the work specified herein. Concrete slab shall not exceed 1/8" in 10'-0" from required plane. Notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected. Installation of precast concrete pavers and associated construction constitutes acceptance of the adjacent and underlying construction.
- B. Installation of Mortar bed as per TCA F102 - 95. All materials used follows instructions of manufacturer for use in mortar method.
- C. Install precast concrete pavers
- D. Grouting of pavers in strict accordance with grout manufacturer's directions and instructions. Latex or acrylic additives of the same manufacturer as the grout.
- E. All control and expansion joints to be installed as per TCA EJ 171-94. All joint materials said to follow manufacturer's directions and instructions.
- F. Field cut precast pavers in accordance with manufacturer's recommendations for methods, equipment and precautions.

### **3.03 CLEANING AND PROTECTION**

- A. Remove and replace pavers that are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment to eliminate evidence of replacement.
- B. Cleaning: Remove mortar stains and all other types of soiling from exposed paver surfaces, wash and scrub clean.
- C. Provide final protection and maintain conditions in a manner acceptable to installer, which ensures paver work being without damage or deterioration at time of substantial completion.

**END OF SECTION**

## SECTION 32 31 00

### TUBE STEEL FENCES AND GATES

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install all tubular steel fence system, as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the Industry Standards and References.

##### 1.04 QUALITY ASSURANCE

A. Comply with the Standard requirements established by Manufacturer.

B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00 Submittal Procedures.

B. Provide:

1. Materials list of items proposed to be provided under this Section;
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
3. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades.
4. Manufacturer's recommended installation procedures which, when accepted by the Architect, will become the basis for accepting or rejecting actual installation procedures for the Work.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Sections 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

A. Comply with the requirements of Sections 01 50 00.

B. Comply with Manufacturer's Standard Requirements.

##### 1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00.

##### 1.10 WARRANTY

Provide Manufacturer's Standard Warranty in accordance with Section 01 78 36 Warranties.



## **PART 2 – PRODUCTS**

### **2.01 MATERIALS AND FABRICATION**

- A. All steel material for posts and rails shall have a minimum yield strength of 45,000 psi (310 MPa).
- B. All HSS tubing to conform to ASTM A500, cold formed steel tubing.
- C. Posts for end, corner and line types as indicated below:
  - 1. Fence: Tube steel per Plans
  - 2. Vehicular and Trash Enclosure Gates: Tube steel per Plans
  - 3. Man Gates: Tube steel per Plans
  - 4. Provide steel caps at all posts.
  - 5. Add 1'-6" to the gross height of the fence for posts going into concrete footings. If posts are designed to be flange mounted, no additional length is required.
- D. Rails for fences and frames for man gates shall be tube steel sized per Plans. Frames for vehicular and trash enclosure gates to be tube steel sized per Plans.
- E. Frame Corner Construction: Mitered and Welded.
- F. Pickets shall be 1" square tube steel with pressed point (spear shape) top ends. Pickets shall be spaced 4" on center unless otherwise shown on the Drawings.
- G. Finishes:
  - 1. Finish metal components individually prior to assembly
  - 2. Manufacturer Preparation: Hot-Dip galvanize interior and exterior of all metal components in accordance with ASTM A123 standards.
  - 3. Shop Preparation: After shop fabrication, apply hot process galvanizing repair compound to damaged / welded connections and surfaces. Clean by removing all bumps, runs, drips, and organic materials from all surfaces. Rinse and dry after cleaning. Profile the exterior galvanized surfaces using Sweep Blasting, Wash Primer, Acrylic Pre-Treatment methods, or prepare using ASTM D6386 Standards.
  - 4. Shop Priming: Electrostatic applied zincrich epoxy coating, minimum 2 mils (0.0508 mm) thick.
  - 5. Shop Finishing: Electrostatic applied polyester color coat, minimum 2 mils (0.0508 mm) thick.
  - 6. Finished Coating Performance Requirements:
    - a. Adhesion: ASTM D3359, Method B.
    - b. Corrosion Resistance: ASTM B117 and D1654.
    - c. Impact Resistance: ASTM D2794.
    - d. Weathering Resistance: ASTM D822, D2244, and D523, 60 Degree Method.
  - 7. Provide color sample of protective coating as indicated on the Drawings for Architect review and approval.

### **2.02 HARDWARE**

- A. General: Provide standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components unless noted otherwise.
- B. Swing Gate Hardware:

1. Hinges: Provide clamp-on hardware for flat wall or post installation as shown on the Drawings.
    - a. Hinge operation shall be one-way self-closing butt hinges unless shown otherwise on the Drawings.
    - b. Hinges shown on the drawings to be dual acting will also be self-closing butt hinges.
  2. Latches: If no other latch / lock is specified, gate manufacturer shall provide padlock hasp at post and gate for securing the gate. Latch shall be a forked or plunger bar to permit operation from either side of the gate.
  3. Gate pairs shall be provided with drop rod, which shall be accessible only from the interior of the gate and protected by a welded steel box.
- C. Rolling Gate Hardware: Provide following for each gate:
1. Latches:
    - a. Provide forked type or plunger-bar type to permit operation from either side of the gate.
    - b. Provide padlock eye as integral part of latch.
  2. Universal Track Bracket: Provide 10 gage galvanized steel brackets with 3/8" diameter galvanized J-Bolts and nuts.
  3. Rear Wheels:
    - a. Provide 5" outside diameter, 4" diameter V-Groove, galvanized steel roller bearing wheel.
    - b. Anchor rear wheels to gate frame with 5/8" diameter.
  4. Double Wheel Carriage: Provide 1" x 2" x 14 ga. galvanizing steel tube axle with 3/8" diameter galvanized J-Bolts and 6" diameter rubber tire with galvanized steel roller bearing hub.
- D. Man Gate Hardware:
1. Hinges:
    - a. Material: Steel, Heavy-Duty
    - b. Weight Rating: 3,000 lb per pair
    - c. Bearings: Sealed, Roller Bearing
  2. Latches and/or locks
  3. Other

### **PART 3 – EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Ensure property lines and legal boundaries of work are clearly established.
- C. Survey of fence location to be provided by general contractor.
- D. Verify areas to receive fencing are completed to final grade.
- E. Notify the Construction Manager and Architect in writing of any conditions detrimental to the proper and timely completion of the installation.

- F. Correct conditions detrimental to timely and proper completion of the Work.
- G. Do not proceed until unsatisfactory conditions are corrected.
- H. Beginning of installation means acceptance of conditions.

### 3.02 INSTALLATION

#### A. General:

1. Install posts at a maximum spacing of 8 feet on centers.
2. Install corner of slope posts where changes in line or grade exceed a 30° deflection.
3. The distance between end or corner posts shall be divided equally into panels not over 8'-0" long.
4. Install panels at a bias when there is more than a 4" drop for the distance that the panels in this section cover and more than 2" drop within the length of a given panel. A post shall be installed at the top and bottom of each bias.

#### B. Excavating:

1. Drill holes for post footings in firm, undisturbed or compacted soil, strictly adhering to the dimensions and spacing shown.
2. Post hole dimensions:
  - a. Provide 24" deep by 6" diameter foundations for line posts.
  - b. Provide 24" deep by 9" diameter foundations for all other posts. (i.e.: corner and gateposts).
3. Spread soil from excavations uniformly adjacent to the fence line, or on adjacent areas of the site if so directed.
4. When solid rock is encountered near the surface, drill into rock at least 12" for line posts and at least 18" for end, pull, gate, and corner posts. Drill hole at least 1" greater diameter than the largest dimension of the post to be placed.
5. If solid rock is below soil overburden, drill to full depth required, except penetration into rock need not exceed minimum depths as specified above.

#### C. Setting posts:

1. Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
2. Center and align posts in hole.
3. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation.
4. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
5. Trowel tops of footings, and slope or dome to direct water away from posts.
6. Extend footings for gateposts to the underside of bottom hinge.
7. Set keeps, stops, sleeves, and other accessories into concrete as required.
8. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing material or other curing method accepted by the Architect.

9. Grout-in those posts, which are set into, sleeved holes, concrete constructions, or rock excavations, using non-shrink Portland cement grout or other grouting material accepted by the Architect.

D. Concrete strength:

1. Allow concrete to attain at least 75% of its minimum 28-day strength before rails are installed.
2. Do not, in any case, install such items in less than seven days after placement of concrete.
3. Do not hang gates until concrete has attained its full design strength.

E. Installing rails:

1. Install with panel mounting angle clips with screws into post top and bottom.
2. Ensure each panel is level and plumb.
3. Rails shall be mounted to maintain an even 4" above ground.

F. Installing gates:

1. Install gates plumb, level, and secure for full opening without interference.
2. Install ground-set items in concrete for anchorage in accordance with the fence manufacturer's recommendations as accepted by the Architect.
3. Lubricate and adjust the hardware for smooth operation.

3.03 FIELD QUALITY CONTROL

A. Field Tolerances:

1. Post to post spacing: +/- 1/2"
2. Plumbness of Posts: +/- 1/8"
3. Consistency of picket alignment: +/- 1/8"

3.04 ADJUSTING AND CLEANING

- A. Adjust gates to operate smoothly, easily and quietly, free of binding, warp, excessive deflection, distortion, non-alignment, misplacement, disruption, or malfunction, throughout entire operational range.
- B. Confirm that latches and locks engage accurately and securely without forcing or binding.
- C. Repair coatings damaged in the shop or field erection, using a hot-applied repair compound applied in accordance with its manufacturer's recommendations as accepted by the Architect.

**END OF SECTION**

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## SECTION 32 31 00

### VEHICULAR GATE

#### **PART 1 - GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

- A. The contractor shall provide all labor, materials and appurtenances necessary for installation of the steel roll gate system defined herein at project site.
- B. The manufacturer shall supply a total roll gate system of Ameristar® PassPort IS® Impasse Security design series and Gauntlet style. The system shall include all components (i.e., pales, rails, gate uprights, wheels and hardware) required.

##### 1.03 STANDARDS AND REFERENCE

- A. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
- B. ASTM D523 - Test Method for Specular Gloss.
- C. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
- D. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
- E. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- F. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
- G. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- H. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.

##### 1.04 QUALITY ASSURANCE

- A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

The manufacturer's submittal package shall be provided prior to installation.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Upon receipt at the job site, all materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage and to protect against damage, weather, vandalism and theft.

##### 1.08 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 78 36 Operation and Maintenance Data.

1.09 WARRANTY

Provide manufacturer's standard warranty in accordance with Section 01 78 36 Warranties.

**PART 2 - MATERIALS**

2.01 MANUFACTURER

A. Basis of Design Manufacturer: The steel roll gate system shall conform to Ameristar PassPort IS (Impasse Security) design series, Gauntlet style and 3-rail frame configuration manufactured by Ameristar Fence Products, Inc. in Tulsa, Oklahoma.

B. Or Architect approved equal.

2.02 MATERIAL

A. Steel material for roll gate components (i.e. pales, rails, diagonals and uprights), shall be commercial steel with minimum yield strength of 45,000 psi (344 MPa).

B. Ornamental pale material shall be 2-3/4" wide x 3/4" corrugated pales. Pale spacing shall be 6". Material for top rails, uprights and diagonals rails shall be 2" square x 12 Ga. Material for the bottom rail shall be 2" x 4" x 11 Ga. Posts shall be a minimum of 4" square x 11 Ga.

2.03 FABRICATION

A. Pales, rails, uprights and posts shall be precut to specified lengths. Diagonals shall be precut to specified lengths and angles. Frame materials shall be joined by welding. Pales shall be face welded to roll gate frame, except for Invincible or Gauntlet style gates over 18' long. Invincible or Gauntlet style gates over 18' long shall have pales face-welded to 2" x 2" angle iron to form panels equal in length to the gate frame bay width.

B. The manufactured roll gates and bolt-on panels (if applicable) shall be subjected to the PermaCoat® thermal stratification coating process (high-temperature, in-line, multi-stage, multi-layer) including, as a minimum, a six-stage pre-treatment/wash (with zinc phosphate), an electrostatic spray application of an epoxy base, and a separate electrostatic spray application of a polyester finish. The base coat shall be a thermosetting epoxy powder coating (gray in color) with a minimum thickness of 2 mils (0.0508mm). The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall be (specify Black, Bronze, White, or Desert Sand). The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.

C. Completed gates shall be capable of supporting a 200 lb. load applied at midspan without permanent deformation.

**PART 3 - EXECUTION**

3.01 PREPARATION

All new installation shall be laid out by the contractor in accordance with the construction plans.

3.02 INSTALLATION

Gateposts shall be set in accordance with the spacing's shown in the construction plans. The "Earthwork" and "Concrete" sections of this specification shall govern post base material requirements. 6" wheels shall be bolted to the gate (between the wheel plates welded near the ends of the gate bottom rail). The gate shall be set upright with the V-grooved wheels positioned over the pre-installed steel V-track that traverses the gate opening. Roller guides shall be affixed to the gateposts at a height even with the gate top rail to hold the gate in a vertical position. Gate stops shall be welded to the end of the gate or track so gate cannot pass rollers in either direction.

### 3.03 CLEANING

The contractor shall clean the jobsite of excess materials; post hole excavations shall be scattered uniformly away from posts.

<b>Table 2 – Coating Performance Requirements</b>		
Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 1,000 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60° Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

END OF SECTION



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## SECTION 32 31 11

### GATE OPERATORS

#### **PART 1 – GENERAL**

##### 1.01 GENERAL REQUIREMENTS

Division 0, Contract Requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK SUMMARY

Supply and install gate operators as shown on Drawings and as specified herein, including all materials and labor for a timely, complete, and proper installation.

##### 1.03 STANDARDS AND REFERENCES

Comply with the industry standards and references as established by the manufacturer.

##### 1.04 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Installer Qualifications: Firm specializing in work of this Section, with minimum 3 years' experience.

##### 1.05 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.06 SUBMITTALS

- A. Provide in accordance with Section 01 33 00 Submittal Procedures.
- B. Shop drawings: provide illustrate products, installation, and relationship to adjacent construction.
- C. Product data: provide manufacturer's descriptive data and product attributes.

##### 1.07 DELIVERY, STORAGE, AND HANDLING

Comply with the requirements of Section 01 66 00 Product Storage and Handling Requirements.

##### 1.08 PROJECT CONDITIONS

- A. Comply with the requirements of Section 01 50 00 Construction Facilities.
- B. Comply with manufacturer's standard requirements.

##### 1.09 OPERATION AND MAINTENANCE DATA

Provide in accordance with Section 01 77 00 Project Closeout.

##### 1.10 WARRANTY

- A. Provide manufacturer's standard warranty in accordance with Section 01 78 36 Warranties.

#### **PART 2 – PRODUCTS**

##### 2.01 MANUFACTURERS

- A. Basis of Design Manufacturer: LiftMaster. [www.LiftMaster.com](http://www.LiftMaster.com)

## 2.02 MANUFACTURED UNITS

### A. Slide Gate Operators:

1. Model: SL3000UL.
2. Operation: Gear driven.
3. Meet UL 325, UL 991, ASTM F2200, and CAS C22.2 No. 247.
4. Motor: 115 VAC, continuous duty type, sized to gate conditions.
5. Traveling speed: 12 inches per second.
6. Monitoring and controls:
  - a. Internet connectivity: MyQ technology with 50 channel FHSS.
  - b. Built-in Wi-Fi with internet gateway.
  - c. Radio receiver: Security+ 2.0 technology.
  - d. Monitored retro-reflective photo eyes.
  - e. Monitored small profile wired safety edge.
7. Accessories
  - a. Monitored safety devices: [Thru-beam photo eyes.] [Wireless edge with transmitter and receiver.] [Wireless edge transceiver.]
  - b. Wired monitored safety edges: Large profile edge.
  - c. Plug-in loop detector.

### B. Vehicle Detection

1. Detector Model: LOOPDETL
2. Vehicle Detection Loops:
  - a. 6' X 8' Outside Obstruction Loop
  - b. 6' X 8' Inside Obstruction Loop
  - c. 6' X 8' Free Exit Loop
3. Meet UL 325, UL 991, ASTM F2200, and CAS C22.2 No. 247.
4. Motor: 115 VAC, continuous duty type, sized to gate conditions.

## **PART 3 – EXECUTION**

### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

### 3.02 CLOSEOUT ACTIVITIES

- A. Test and adjust operators for proper operation.
- B. Demonstration: Demonstrate operation and programming of operators to Owner.

**END OF SECTION**

## SECTION 32 31 19

### SECURE PERIMETER FENCES AND GATES

#### **PART 1 - GENERAL**

##### 1.01 SUMMARY

Division 0, Contract requirements and Division 1, General Conditions apply to this Section.

##### 1.02 SCOPE OF WORK

The contractor shall provide all labor, materials and appurtenances necessary for installation of the steel corrugated pale security fence system defined herein.

##### 1.03 SYSTEM DESCRIPTION

The manufacturer shall supply a total steel ornamental pale high security fence system of the Ameristar Impasse II model with Gauntlet design. The system shall include all components (i.e., pales, rails, posts, gates and hardware) required.

##### 1.04 QUALITY ASSURANCE

The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

##### 1.05 REFERENCES

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
- C. ASTM D523 - Test Method for Specular Gloss.
- D. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
- E. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- F. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
- G. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- H. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
- I. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

##### 1.06 SUBSTITUTIONS

Substitutions will be considered per Section 01 25 00 Substitution Procedures.

##### 1.07 SUBMITTAL

- A. The manufacturer's submittal package shall be provided prior to installation.

##### 1.08 PRODUCT HANDLING AND STORAGE

- A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

##### 1.09 PRODUCT WARRANTY

- A. All structural fence components (i.e. rails, pales, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 15 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

## **PART 2 - MATERIALS**

### **2.01 MANUFACTURER AND PRODUCT**

- A. Basis of Design manufacturer: Ameristar Perimeter Security Inc., in Tulsa, Oklahoma.
- B. Basis of Design product: The steel ornamental pale high security fence system shall conform to Ameristar Impasse II model, Gauntlet, 3-Rail, style.

### **2.02 MATERIAL**

- A. Steel material for fence framework (i.e., corrugated pales, rails and posts), when galvanized prior to forming, shall conform to the requirements of ASTM A924/A924M, with a minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft<sup>2</sup> (276 g/m<sup>2</sup>), Coating Designation G-90.
- B. Material for corrugated pales shall be a nominal 2.75" x .75" x 14 Ga. The cross-sectional shape of the rails shall conform to the manufacturer's Impasse II® rail design a nominal 2" x 2" x 11 Ga. Pre-drilled holes in the Impasse II® rail shall be spaced 6" on center, providing a pale airspace of no greater than 3.25" or Pre-drilled holes in the Impasse II Anti-Scale rail shall be spaced 4.1875" on center, providing a pale airspace of no greater than 1.5" (38mm). Tamperproof fasteners shall be used to fasten each pale to rail at every intersection. Fence posts and gate posts shall meet the minimum size requirements of Table 1.
- C. If applicable - Material for steel Impasse II privacy screening shall be 18ga. preformed slats, providing complete screening coverage between pales and at pale to post connections. Impasse II privacy screening shall provide screening from top rail to bottom rail, and be capable of traversing terrain without impeding the raking capabilities of the fencing panel. Privacy screening not available for Impasse II Anti-Scale model.

### **2.03 FABRICATION**

- A. Pales, rails and posts shall be pre-cut to specified lengths. Impasse II rails shall be pre-punched to accept tamperproof security fasteners. Post flange shall be pre-punched to accept rail to post attachment. Post web shall be punched providing a clear opening for interior of rails to align throughout the entire system for affixing conduit, video cabling, IDS wiring, and other components for a complete systems integration. Impasse II rails shall be attached to post flange providing a bracket-less design at each intermediate post.
- B. The manufactured galvanized framework shall be subjected to the PermaCoat® thermal stratification coating process (high-temperature, in-line, multi-stage, multi-layer) including, as a minimum, a six-stage pretreatment/wash, an electrostatic spray application of an epoxy base, and a separate electrostatic spray application of a polyester finish. The base coat shall be a thermosetting epoxy powder coating (gray in color) with a minimum thickness of 2 mils (0.0508mm). The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall be (specify Black, Bronze, White, or Desert Sand). The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2.
- C. Completed panels shall be capable of supporting a 400 lb. load (applied at midspan) without permanent deformation. Panels shall be biasable to a 30° change in grade.
- D. Impasse II fence system shall be designed to minimize the system impedance to comply with IEEE grounding requirements. No additional grounding material, beyond the structure

grounding lug installation, will be required to create a safe low resistance fence system. By way of fence construction, the entire fence system is inherently grounded without the need for any additional work. Grounding location at the post is for taking the fence system to site ground.

- E. Swing gates shall be fabricated using 2" sq. x 12ga rail, 2" sq. x 12ga. gate ends, and 2.75" x .75" x 0.075 pales. Gates that exceed 6' in width will have a 2" sq. x 11ga. intermediate upright. All rail and upright intersections shall be joined by welding. All pale and rail intersections shall also be joined by welding.
- F. Pedestrian swing gates shall be self-closing, having a gate leaf no larger than 48" width. Integrated hinge-closer set (2 qty) shall be ADA compliant that shall include a variable speed and final snap adjustment with compact design (no greater than 5" x 6" footprint). Hinge-closer set (2 qty) shall be tested to a minimum of 500,000 cycles and capable of self-closing gates up to a maximum gate weight of 260 lbs. and maximum weight load capacity of 1,500 lbs. Hinge-closer device shall be externally mounted with tamper-resistant security fasteners, with full range of adjustability, horizontal (.5" - 1.375") and vertical (0 - .5"). Maintenance free hinge-closer set shall be tested to operate in temperatures of negative 20 F to 200 F degrees, and swings to negative 2 degrees to ensure reliable final lock engagement. Infill metal panel to be 16-gauge, perforated panel, round hole, 1/8" round on 3/16" staggered centers.
- G. Sliding gates. Refer to Section 32 31 00 Vehicular Gate.

### **PART 3 - EXECUTION**

#### **3.01 PREPARATION**

All new installation shall be laid out by the contractor in accordance with the construction plans.

#### **3.02 FENCE INSTALLATION**

Fence post shall be spaced according to Table 3, plus or minus 1/4". For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to the line and end posts with fasteners supplied by the manufacturer. Attachment to corner post shall be made using brackets and fasteners supplied by the manufacturer (See Figure 1). Posts shall be set in concrete footers having a minimum depth of 36" (Note: In some cases, local restrictions of freezing weather conditions may require a greater depth). The "Earthwork" and "Concrete" sections of this specification shall govern material requirements for the concrete footer. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.

#### **3.03 FENCE INSTALLATION MAINTENANCE**

When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces; 1) Remove all metal shavings from cut area. 2) Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. 3) Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufactures' warranty.

#### **3.04 GATE INSTALLATION**

Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application; weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacture of the gate and shall be installed per manufacturer's recommendations.

### 3.05 CLEANING

The contractor shall clean the jobsite of excess materials; post-hole excavations shall be scattered uniformly away from posts.

<b>Table 1 – Minimum Sizes for Impasse II® Posts</b>				
<u>Fence Posts (Nominal)</u>	<u>Panel Height</u>			
3" x 2.75" x 12 Ga. I-Beam	Up to & Including 8' Height			
4" x 2.75" x 11 Ga. I-Beam	Over 8' Height up to & including 10' Height			
<u>Gate Leaf</u>	<u>Gate Height</u>			
	<u>Up to &amp; Including 6'</u>	<u>Over 6' Up to &amp; Including 8'</u>	<u>Over 8' Up to &amp; Including 10'</u>	<u>Over 12'</u>
Up to 4'	3" x 12Ga.	3" x 12 Ga.	4" x 11 Ga.	4" x 11 Ga.
4'1" to 6'	3" x 12Ga.	3" x 12 Ga.	4" x 11 Ga.	4" x 11 Ga.
6'1" to 8'	4" x 11 Ga.	6" x 3/16"	6" x 3/16"	6" x 3/16"
8'1" to 10'	4" x 11 Ga.	6" x 3/16"	6" x 3/16"	6" x 3/16"
10'1" to 12'	6" x 3/16"	6" x 3/16"	6" x 3/16"	8" x 1/4"
12'1" to 16'	6" x 3/16"	6" x 3/16"	8" x 1/4"	8" x 1/4"

<b>Table 2 – Coating Performance Requirements</b>		
<u>Quality Characteristics</u>	<u>ASTM Test Method</u>	<u>Performance Requirements</u>
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 3,500 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D2244, D523 (60° Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

<b>Table 3 – Impasse II® Post Spacing</b>		
<u>Span</u>	<u>8' Nominal (95" Rail)</u>	
	<b>Line &amp; End Posts</b>	
Post Size	3" x 2.75" x 12 Ga. I-Beam	4" x 2.75" x 11 Ga. I-Beam
Post Settings ± ¼" O.C.	96"	96"

\*For Corner Posts see Figure 1

**Figure 1**

