



SCREW PRESS SLUDGE DEWATERING PROJECT

FOR

**COUNTY SERVICE AREA (CSA) 70 – GLEND HELEN
DEVORE, CALIFORNIA**

**WARNING: ALL INDIVIDUALS INTERESTED IN
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THE PROJECT.**



SECTION F

TECHNICAL SPECIFICATIONS

**SCREW PRESS SLUDGE
DEWATERING PROJECT**

FOR

**COUNTY SERVICE AREA (CSA) 70 – GLEN HELEN
DEVORE, CALIFORNIA**

PROJECT NO. 30.30.0028



SECTION F

TECHNICAL SPECIFICATIONS

**LYTLE CREEK NORTH
WASTEWATER RECYCLING PLANT
CSA 70 GH SCREW PRESS SLUDGE
DEWATERING**

**FOR
COUNTY SERVICE AREA 70-GH
DEVORE, CALIFORNIA**

PROJECT NO. 30.30.0028

ACCOUNT NO.: 3060004656

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"NOT FOR BID"

SECTION 011100 – SUMMARY OF WORK

PART 1 – GENERAL

1.1. WORK INCLUDED

- A. Construct work as described in the Contract Documents.
 - 1. Provide utility conflict survey prior to mobilizing to job site; locate crossing/conflicting utilities and submit to OWNER for review and acceptance prior to first pay application.
 - 2. Provide the materials, equipment, and incidentals required to make the project completely operable.
 - 3. Provide the labor, equipment, tools and consumable supplies required for a complete project.
 - 4. Provide such temporary works as may be required to maintain the full and normal functionality of all portions of the plant throughout the construction and commissioning processes.
 - 5. Provide the civil, architectural, structural, mechanical, electrical, instrumentation and all other work required for a complete and operable project.
 - 6. Test and place the completed project in operation as described in the specific mechanical equipment Specific Sections.
 - 7. Provide the special tools, spare parts, lubricants, supplies, polymer, and manufacturer-recommended spare parts or other materials as indicated in Contract Documents for the operation and maintenance of the Project.
 - 8. Remove, salvage and provide to OWNER at such place or places as he may direct all equipment, tools and appurtenances noted in the Plans and these specifications to be salvaged.
 - 9. Remove and dispose the items noted in the demolitions plans.
 - 10. Drawings and specifications do not indicate or describe all of the work required to complete the project in exhaustive detail. Additional details required for the correct installation of selected products are to be provided by the CONTRACTOR and coordinated with the ENGINEER.

1.2. JOB CONDITIONS

- A. The General Provisions, the Supplementary Conditions, and General Requirements apply to each specification sections.
- B. Comply with all applicable state and local codes and regulations pertaining to the nature and character of the work being performed.

1.3. DESCRIPTION OF WORK

- A. Work is described in general, non-inclusive terms as

1. Install and place in service one (1) mechanical sludge dewatering system, fully integrated and controlled by the screw press manufacturer, including all related controls and appurtenances. Equipment named below is the basis of design; bidders may request substitutes as defined in Sections 01 25 00 and 46 76 00
2. Equipment includes (but is not limited to);
 - a. Huber Screw Press Q-440.2 by Huber Technology, Inc., or approved equal, including solids handling accessories:
 - (i) New Progressing Cavity WAS Pump (Seepex series BN), or approved equal
 - (ii) Polymer blending/conditioning and feed system (Model M240-P2-AB by UGSI, or approved equal) in a heated, lighted FRP Shed
 - (iii) Dewatered Cake conveyor: Model Ro8t by Huber Technology, Inc, or approved equal
 - b. Installation of new DIP sludge fill lines with plug valve fill ports on wall-mounted pipe supports
 - c. New dewatered sludge offloading pad with metallic inserts for dumpster roller pad and electric wire rope winch
 - d. Pre-engineered metal canopy system
3. RAS/WAS flow controls at the existing flow distribution box: Reconfigure the WAS piping and valves at the distribution box on the north side of the secondary clarifiers to allow direct feed of RAS to the ditches while bypassing WAS operations. Add one SCADA-controlled 6-in motor-actuated plug valve. Add motor actuation to the existing 6-in plug valve and provide connections to SCADA.
4. Yard piping, valves, vaults, and controls to effectuate the normal operation of the sludge dewatering system.
5. Concrete, metals, piping, valves, electrical, instrumentation, controls and appurtenances associated with these items.
6. Demolition of concrete pad walls, supports, pipes, light pole, etc.

1.4. WORK UNDER OTHER CONTRACTS

- A. The following items of work are not included in this contract, but may impact construction scheduling, testing, and start up
 1. No anticipated construction under other contracts.

1.5. WORK BY OWNER

- A. The OWNER plans to perform the following items of work which are not included in this contract, but may impact construction scheduling, testing, and start up
 1. None.
- B. Completion of the work described in this contract may impact the construction and testing of the items listed above.

1. Coordinate construction activities through the OWNER.
2. Pay claims for damages which result from the late completion of the project or any specified milestones.
- C. OWNER will provide normal operation and maintenance of the existing facilities during construction, unless otherwise stated.

1.6. OWNER-SELECTED PRODUCTS

- A. None

1.7. OWNER-PROVIDED PRODUCTS

- A. None

1.8. CONSTRUCTION OF UTILITIES

- A. Existing utilities will be used for this project to the extent practicable
- B. Reuse existing conduit runs to the extent practicable
- C. Install new conduit runs and water lines as shown on the Drawings.

1.9. OCCUPANCY

- A. As soon as any portion of the structure and equipment are ready for use, the OWNER shall have the right to operate the portion upon written notice to the CONTRACTOR.
- B. Testing of equipment and appurtenances including specified test periods, training, and start-up does not constitute acceptance for operation.
- C. OWNER may accept the facility for continued use after start-up and testing at the option of the OWNER. If acceptance is delayed at the option of the OWNER, shut down facilities per approved Operation and Maintenance procedures.
- D. The execution of bonds is understood to indicate the consent of the surety to these provisions.
- E. Provide an endorsement from the insurance carrier permitting occupancy of the structures and use of equipment during the remaining period of construction.
- F. Conduct operations to ensure the least inconvenience to the OWNER and general public.

1.10. COORDINATION

- A. Sequence, coordinate, and integrate the various elements of mechanical, electrical, and other systems, materials, and equipment.
- B. Coordinate mechanical and electrical systems, equipment, and materials installation with other components.
- C. Verify all dimensions by field measurements.
- D. Arrange for chases, slots, and openings during progress of construction.
- E. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
- F. Install systems, materials, and equipment as permitted by codes to provide the maximum headroom possible where mounting heights are not detailed or dimensioned.
- G. Coordinate the connection of systems with exterior underground and overhead utilities and services. Comply with the requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to the greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Adjust routing of piping, ductwork, utilities, and location of equipment as needed to resolve spatial conflicts between the various trades at no additional cost. Document changes in the indicated routings on the record drawings.
- I. Install systems, materials, and equipment level and plumb, parallel and perpendicular to structure's surfaces.
- J. Install systems, materials, and equipment to facilitate servicing, maintenance, and repair or replacement of components. As much as practical, connect for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to accessible locations.
- K. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

1.11. FIELD MEASUREMENTS

- A. Perform complete field measurements for products required to fit existing conditions prior to purchasing products or beginning construction.
- B. Verify property lines, control lines, grades, and levels indicated on the Drawings.
- C. Verify pipe class, equipment capacities, existing electrical systems and power sources for existing conditions.
- D. Check Shop Drawings and indicate the actual dimensions available where products are to be installed.
- E. Include field measurements in record drawings as required in Section 013200 "Construction Progress Documentation".

1.12. RECORD DRAWINGS

- A. Mark drawings to record actual construction, including the following:
 - 1. Details not on the original Drawings. Include field verified dimensions and clarifications, interpretations, and additional information issued in response to Requests for Information.
- B. Submit documents with uniform markings.
 - 1. Mark submittals to:
 - a. Mark dimensions with the prefix FD to indicate field verified dimensions on the Shop Drawings

PART 2 – PRODUCTS [NOT USED]

END OF SECTION

SECTION 011400 – WORK RESTRICTIONS

PART 1 – GENERAL

1.1. SUMMARY

- A. Section includes: Requirements for sequencing and scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.
- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's work.
- C. Related Bid Document sections include, but are not necessarily limited to:
 - a. Section A – Bidding Requirements
 - b. Section B – Contract Agreements and Forms
 - c. Section D – General Provisions

1.2. SUBMITTALS

- A. CONTRACTOR shall provide the following items within 30 days of Notice to Proceed in accordance with Section 013323.
 - 1. Baseline Schedule with MOP tasks.
 - 2. Method of Procedure (MOP) Form.
 - 3. Method of Procedure (MOP) Log.
 - 4. Progress Schedule with MOP tasks.

1.3. GENERAL CONSTRAINTS ON SEQUENCE AND SCHEDULING OF WORK

- A. General Constraints
 - 1. The Lytle Creek North Wastewater Recycling Plant (WRP) is a domestic wastewater treatment plant located near the confluence of Cajon Wash and Lytle Creek, approximately 2-miles west of I-215. Impairing the operational capabilities of this treatment plant can result in serious environmental damage and monetary fines.
 - 2. Conduct Work in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the water quality limitations specified in the discharge permit.

3. Conduct commissioning and process start-up activities as specified in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the water quality limitations specified in the discharge permit.
 4. The status of the treatment plant shall be defined as "operational" when it is capable of treating the entire quantity of wastewater received to the water quality limits specified in the discharge permit.
- B. Work sequence and constraints:
1. Utilize description of critical events in work sequence in this Section as a guideline for scheduling and undertaking the Work.
 2. Work sequence and constraints presented do not include all items affecting completion of the Work but are intended to describe critical events necessary to minimize disruption of the existing facilities and to ensure compliance with National Pollutant Discharge Elimination System permit requirements.
- C. Instrumentation and controls process performance testing.
- D. After the Process Operational Period, test process control system as specified.
- 1.4. SHUTDOWN AND CONSTRUCTION CONSTRAINTS
- A. General shutdown constraints:
1. Execute the Work while the existing facility is in operation.
 2. Some activities may be accomplished without a shutdown.
 3. Apply to activities of construction regardless of process or work area.
 4. Activities that disrupt plant or utilities operations must comply with these shutdown constraints.
 5. Organize work to be completed in a minimum number of shutdowns.
 6. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.
 7. Minimize treatment process interruptions while complying with specified sequencing constraints.
 8. Provide temporary pumping, power, lighting, controls, instrumentation, and safety devices as required to accomplish the intent of the WORK at no additional cost to the OWNER.
 9. Final determination of the permitting of shutdowns will be the sole judgment of the OWNER.
 10. OWNER maintains the ability to abort on the day of the scheduled shutdown.
 11. CONTRACTOR shall provide a minimum of 2 weeks notification to the OWNER prior to a scheduled shutdown.
- B. Perimeter Fencing:

1. The CONTRACTOR shall always maintain restricted plant access throughout construction. This may include temporary perimeter fencing provided by the CONTRACTOR.
 - C. Road Access:
 1. CONTRACTOR shall maintain plant access throughout the construction period and shall maintain accessibility of the gate and roadway to the plant site for OWNER vehicular access.
 - D. General maximum plant flow work limitations:
 1. Activities that disrupt plant operations are prohibited during high wet-weather flow events or high diurnal flow events, generally defined as plant influent flows exceeding 0.5 million gallons per day.
 - E. Unit process availability work limitations:
 1. Shutdowns and tie-ins or other activities that disrupt plant operations are prohibited unless alternative or standby unit process availability conditions exist, and no processes shall be taken out of service until the new treatment or pumping component is fully operational.
 - F. Shutdown activities:
 1. Scheduling:
 - a. Shutdown activities must be coordinated with Plant Staff. Submit notification of required shutdowns of existing facilities at least 14 days prior to the planned date of shutdown, unless specified herein.
 - G. Dewatering of existing process and disposal of residue:
 1. When the OWNER has turned the process unit over to the CONTRACTOR for modification or temporary use, the CONTRACTOR is responsible for costs and procedures required to dewater and dispose of liquid, solids, etc. in the process unit.
 2. Drainage and disposal of process unit liquids, solids, etc. into another treatment process unit on the plant site may be allowed if approved in advance by the ENGINEER and OWNER and is conducted in accordance with OWNER's requirements.
 3. CONTRACTOR shall provide adequate time in schedules for draining and cleanup of basins and channels.
 4. CONTRACTOR shall provide all equipment necessary to dewater and remove debris. All dewatering and cleaning equipment shall be at no additional cost to the OWNER.
- 1.5. METHOD OF PROCEDURE (MOP)
- A. MOP Instructions: See Appendix A of this section.
 - B. Prepare MOP for the following conditions:
 1. Shutdowns, diversions, and tie-ins to the existing facility.
 2. Process start-up activities.
 3. Power interruption and tie-ins.

4. Switch over between temporary and permanent facilities, equipment, piping, and electrical and instrumentation systems.
 5. Process constraints requiring interruption of operating processes or utilities.
 6. Tie-in and core drilling into existing facility structures and related bulkhead installations.
- C. Other Work not specifically listed may require MOPs as determined necessary by the CONTRACTOR, OWNER, or ENGINEER.
 - D. Submit Baseline Schedule with proposed MOPs.
 - E. Submit MOP Log at construction progress meetings.
 - F. No consideration will be given to claims of additional time and cost associated to prepare MOPs required by the OWNER and ENGINEER to complete this work in a manner that facilitates proper operation of the facility and compliance with effluent discharge criteria.
 - G. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.6. COMPLIANCE WITH DISCHARGE PERMIT

- A. The existing facility is operating under the terms of a California Regional Water Quality Control Board Waste Discharge Requirement, Order No R8-2007-0004. This permit specifies the water quality limits that the plant must meet prior to discharge of effluent. A copy of the existing permit is on file for review at the Plant Administrative Office.
- B. Perform work in a manner that will not prevent the existing facility from achieving the finished water quality requirements established by regulations.
- C. Bear the cost of penalties imposed on the OWNER for discharge violations caused by actions of the CONTRACTOR.

1.7. REQUIREMENTS FOR SAFE WORKING ATMOSPHERE

- A. Provide temporary ventilation, including all necessary electrical and mechanical provisions, as needed at any facility as required for a safe working environment for the entire duration of the Work.
- B. Prior to interruption of existing ventilation in any area of the Work, provide temporary ventilation sized to maintain a minimum of six air changes per hour in each individual room or space that would be impacted.
- C. Temporary ventilation shall not interfere with new construction.

1.8. REQUIREMENTS FOR OPERATION OF PLANT AND MAINTAINING CONTINUOUS OPERATION OF EXISTING FACILITIES

- A. Facilities or conditions required to keep the existing plant operational include, but are not limited to, the following:
 1. Electrical power including transformers, distribution wiring, and motor control centers.
 2. Existing RAS/WAS pumping.
 3. Piping for conveyance of raw, partially treated and finished wastewater between treatment or storage units and basins.
 4. Plant drains

5. Laboratory facilities.
 6. Office, toilets, and washrooms.
 7. Fencing and gates.
 8. Lighting.
 9. Heating, ventilation, and air conditioning.
 10. Instrumentation, meters, controls, and telemetry equipment.
 11. Safety equipment and features.
 12. Parking for District employees and vehicles required for operation and maintenance of the Plant.
 13. Telephone system.
 14. Storm drainage.
- B. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational.
- C. Do not remove or demolish existing facilities required to keep the existing plant operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment.
1. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.
- D. One (1) sludge holding tank shall remain operational and in service at all times except for short shutdowns (8-hours) as coordinated with the County. Contractor shall allow for 2 days for the County to dewater the first sludge holding tank; 1 day to fill and test each sludge holding tank. The first sludge holding tank shall be completed, tested, and accepted by the County prior to starting work on the second sludge holding tank.

1.9. OPERATIONS AND MAINTENANCE ACCESS

- A. Provide safe, continuous access to process control equipment for plant operations personnel.
- B. Provide access on 1-hour advance notice to process control equipment for plant maintenance personnel and associated maintenance equipment.

1.10. UTILITIES

- A. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.
- B. New yard utilities were designed using existing facility drawings.
 1. Field verification of utilities locations was not performed during design.
 2. Services crossed may require relocation and possible shutdowns.
 3. Pipe alignments as indicated on the Drawings.

1.11. COORDINATION OF WORK

- A. Maintain overall coordination of the Work.

- B. Obtain construction schedules from subcontractors and suppliers and assume responsibility for correctness.
- C. Incorporate schedules from subcontractors and suppliers into Progress Schedule to plan for and comply with sequencing constraints.

1.12. WORK BY OTHERS

- A. Where the Work depends upon work by others, inspect and promptly report discrepancies.

1.13. WORK SEQUENCE

- A. CONTRACTOR shall submit an outline of work sequence as part of the MOP Plan for review and approval by OWNER and ENGINEER prior to construction.

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION [NOT USED]

3.1. WORK SEQUENCE

- A. Any dewatering or bypass pumping required as part of the project is subsidiary to the cost of the project.

END OF SECTION

APPENDIX A

“Method of Procedure” (MOP) Instructions and Forms

Definition and Purpose

“Method of Procedure” (MOP) is a detailed document submitted by the CONTRACTOR to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the OWNER and ENGINEER that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The OWNER should use the information within the MOP to define operational procedures and methods to safely and successfully assist the CONTRACTOR.

MOP Process Summary

Who	Step	Timing
CONTRACTOR	1. Identify MOPs needed on MOP Log and Baseline Schedule.	7 days prior to Preconstruction Scheduling Meeting
CONTRACTOR, OWNER, Engr	2. Pre-MOP Meeting.	More than 28 days prior to work
CONTRACTOR	3. Submits MOP.	No later than 28 days prior to work
OWNER	4. Reviews MOP.	
OWNER	5. MOP finalized.	7 days prior to work
CONTRACTOR	6. Complete Readiness Checklist.	5 days prior to work
CONTRACTOR	7. Complete Safety Checklist.	Just prior to commencing work
CONTRACTOR	8. Complete Work.	
CONTRACTOR	9. Update MOP Log and Schedules.	Monthly

MOP PROCESS DETAIL

STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.

CONTRACTOR submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting.

CONTRACTOR requests a Pre-MOP Meeting with the OWNER and ENGINEER to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the OWNER or ENGINEER if the work is deemed to be minor.

STEP 3. Submits MOP.

CONTRACTOR completes the MOP Form and submit 3 copies for approval to the OWNER's Project Manager (OPM).

STEP 4. Reviews MOP.

OPM distributes MOP Form for review by the OWNER's Construction Coordinator, O&M Representative, and ENGINEER's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in contract documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the OWNER, ENGINEER, and CONTRACTOR.

STEP 6. Complete Readiness Checklist.

CONTRACTOR verifies everything is ready for the work.

STEP 7. Complete Safety Checklist.

CONTRACTOR ensures safety.

STEP 8. Complete work.

CONTRACTOR complete work.

STEP 9. Update MOP Log and Progress Schedules.

CONTRACTOR updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

Method of Procedure (MOP) Form

OWNER: _____ Date: _____
 CONTRACTOR: _____ Project No.: _____
 Project Name: _____ Submittal No.: _____
 Submittal Title: _____ Spec/Dwg. Reference: _____

MOP #	Task Title: (< 5 word title)	Submittal Date: (No later than 28 days prior to work)
SCHEDULE OF WORK ACTIVITY START: (Date/Time) END: (Date/Time)		
REQUESTOR:		
PRIMARY POINT OF CONTACT:		PHONE/PAGER:
SECONDARY POINT OF CONTACT:		PHONE/PAGER:
NOTIFY	Control Room, Phone	Security, Phone
BUILDING:		LOCATION OF WORK FLOOR/LEVEL:
DESCRIPTION OF WORK: (Provide sufficient details on process isolation, work sequencing, and safety (i.e., control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)		
Process(s):		
Trades Affected:		
WORK PLAN:		
Work Sequencing: _____		
Process Isolation: _____		
Spill Prev. Plan: _____		
Conting. Plans: _____		

Table continued next page.

CRITICAL EQUIPMENT/TOOLS: (pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)					
	Acoustic Ceiling/or Walls Access		Excavation Permit		Lock Out/Tag Out
	Chemical Use Approval		Fire Sprinkler Impairment		Life Safety Systems
	Confined Space Permit		Flammable Materials		Roof Protocol
	Critical Lift Plan		Flush / Discharge		Work After Dark
	Energized Electrical Work		High Pressure Test		
	Elect. Panel Schedules		Hot Work/Open Flame		
EXISTING SERVICE(S) AT RISK:					
	Breathing Air		Elect Normal		Process Access
	Chemical Distribution		Fire Protection		Safety Showers
	City Water		HVAC		SCADA
	Communication		Inert Gas		Security
	Domestic Drain		Instrument - Air		Solvent Drain
	Elect-Bus Duct		Life Safety System		Specialty Gases
	Elect Emergency		Natural Gas		Storm Drain
REVIEWER'S INSTRUCTIONS / COMMENTS:					
PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:					
	Full Name (printed)	Initialed	Phone	Date	
Submitted By:					
OWNER:					
ENGINEER:					
Reviewer:					

Readiness Checklist

(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____

2. Review work plan: _____

3. Review contingency plan: _____

SAFETY CHECKLIST

(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive; add special considerations as required

1. Location awareness:
 - a. Emergency exits: _____
 - b. Emergency shower and eyewash: _____
 - c. Telephones and phone numbers: _____
 - d. Shut-off valve: _____
 - e. Electrical disconnects: _____
2. Inspect work area:
 - a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. MSDS (Material Safety Data Sheets):
 - a. Understand the chemicals and substances in the area you are working in by reading the MSDS.
4. Lockout/Tagout Procedure:
 - a. Lockout/tagout energy sources before beginning work.
 - b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
 - c. Make sure the lines are depressurized.
5. Overhead work:
 - a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
 - b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
 - c. Spotter assigned and in position.
 - d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
 - a. Shepherd's hook.
 - b. ARC flash protection.
 - c. Fire extinguisher.
 - d. Other: _____
7. Accidents:
 - a. Do NOT shut off and do not attempt to correct the situation, unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
 - a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
 - a. Do not obstruct evacuation routes.
 - b. Take time to survey the area for evacuation routes.

Method of Procedure (MOP) Log

Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (yes/no)
001					
002					
003					

END OF SECTION

SECTION 012500 – SUBSTITUTION PROCEDURES

PART 1 – GENERAL

1.1. CONTRACTOR'S OPTIONS

- A. For products specified only by reference standards, select any product meeting standards.
- B. For products specified by naming several products or manufacturers, select any names.
- C. For products specified by naming one or more products, followed by "or equal", CONTRACTOR must submit request for substitution for any product not specifically named.
- D. For products specified by naming only one product and manufacturer, no option and no substitution will be allowed.
- E. Related Bid Document sections include, but are not necessarily limited to:
 - a. Section A – Bidding Requirements
 - b. Section B – Contract Agreements and Forms
 - c. Section D – General Provisions

1.2. SUBSTITUTIONS

- A. Within 20 days after award of Contract (unless noted otherwise), the District will consider formal requests from CONTRACTOR for substitution of products in place of those specified.
- B. Submit five copies of each request for substitution, including:
 - 1. Complete data substantiating compliance of proposed substitution with Contract Documents.
 - 2. For products:
 - a. Product identification, including name and address of manufacturer.
 - b. Product description, performance and test data, and reference standards.
 - 3. For construction methods:
 - a. Detailed description of proposed method.
 - b. Illustration drawings.
 - 4. Changes in construction schedule.
 - 5. Accurate cost data in comparison with product or method specified.
- C. In making request for substitution, CONTRACTOR represents that:
 - 1. He has investigated proposed substitution and determined that it is equal or superior to that specified in all aspects.
 - 2. He will provide same warranty as for product or method specified.
 - 3. He will coordinate installation of accepted substitution into Work, making changes as may be required to complete work in all aspects.
 - 4. He waives all claims for additional costs related to substitution which subsequently become apparent.

- 5. Cost data is complete and includes all related costs under Contract, excluding District's redesign.
- D. Substitutions will not be considered if:
 - 1. They are indicated or implied on shop drawings or data submittals without formal request.
 - 2. Acceptance will require substantial revision of Contract Documents.
- E. CONTRACTOR alone will be responsible for substantiating acceptability of proposed substitutions. District's decision in acceptance or non-acceptance of substitutions shall be final.
- F. CONTRACTOR will be responsible for all costs incurred by County associated with review and approval of proposed alternate manufacturer's equipment.

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION [NOT USED]

Request for Substitution Form:

TO: _____

PROJECT: _____ DATE: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

SECTION

PARAGRAPH

SPECIFIED ITEM

Proposed Substitution: _____

Reason for Substitution: _____

Include complete information on changes to Drawings and/or Specifications which proposed substitution will require for its proper installation.

Fill in Blanks Below:

A. Will the undersigned CONTRACTOR pay for changes to the building design, including Districting and detailing costs caused by the requested substitution?

B. What effect does substitution have on other trades?

C. Differences between proposed substitution and specified item?

D. Differences in product cost or product delivery time?

E. Manufacturer's guarantees of the proposed and specified items are:

_____ Equal _____ Better (explain on attachment)

The undersigned states that the function, appearance, and quality are equivalent or superior to the specified item.

Submitted by:

For Use by District

___ Recommended ___ Recommended as noted

Signature _____ ___ Not recommended ___ Received too late

Firm _____ By _____

Address _____ Date _____

Date _____ Remarks _____

Telephone _____

For Use by District:

_____ Approved _____ Rejected

Project District _____ Date _____

END OF SECTION

SECTION 013119 – PROJECT MEETINGS

PART 1 – GENERAL

1.1. SUMMARY

- A. Work Included: To enable orderly review during progress of the Work, and to provide for systematic discussion of problems, the ENGINEER will conduct project meetings throughout the construction period.
 - 1. The CONTRACTOR's relations with his subcontractors and material suppliers, and discussions relative thereto, are the CONTRACTOR's responsibility and normally are not part of project meetings content.
- B. Related Bid Document sections include, but are not necessarily limited to:
 - a. Section A – Bidding Requirements
 - b. Section B – Contract Agreements and Forms
 - c. Section D – General Provisions
- C. Work Included: To help clarify construction contract administration procedures, the ENGINEER will conduct a Preconstruction Meeting prior to start of the Work.

1.2. REFERENCES [NOT USED]

1.3. ADMINISTRATIVE REQUIREMENTS

- A. Preconstruction Meeting
 - 1. The Meeting will be scheduled to be held following project award.
 - 2. Attendance:
 - a. Provide attendance by authorized representatives of the CONTRACTOR and major subcontractors.
 - b. The ENGINEER will advise other interested parties and request their attendance.
 - c. ENGINEER.
 - d. San Beraridno County Special Districts
 - 3. Minimum agenda: Data will be distributed and discussed on:
 - a. Organizational arrangement of CONTRACTOR's forces and personnel, and those of subcontractors, materials suppliers, and the ENGINEER.
 - b. Channels and procedures for communication.
 - c. Construction schedule including sequence of critical work.
 - d. Contract Documents including distribution of required copies of Drawings and revisions.
 - e. Processing of Shop Drawings and other data submitted to the ENGINEER for review. CONTRACTOR shall provide a list of all shop drawings anticipated to be submitted during construction.

- f. Processing of field decisions and Change Orders.
- g. Rules and regulations governing performance of the Work.
- h. Procedures for safety and first aid, security, quality control, housekeeping, and related matters.
- i. Procedures for maintaining record documents.
- j. Inspections and Testing.

1.4. SUBMITTALS [NOT USED]

- A. To the maximum extent practicable, advise the OWNER and the ENGINEER at least 24 hours in advance of the Conference as to items to be added to the agenda.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6. CLOSEOUT SUBMITTALS [NOT USED]

1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8. QUALITY ASSURANCE

- A. For those persons designated by the ENGINEER to attend and participate in project meetings, provide required authority that does not require OWNER approval to commit the CONTRACTOR to solutions agreed upon in the project meetings.
- B. For those persons designated by the CONTRACTOR, his subcontractors, and suppliers to attend the Preconstruction Conference, provide required authority to commit the entities they represent to solutions agreed upon in the Conference. The ENGINEER will attend to answer questions.
- C. The ENGINEER will compile minutes of the Conference and will furnish a copy of the minutes to everyone in attendance. The CONTRACTOR may make and distribute such copies as he wishes.

1.9. DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10. FIELD CONDITIONS [NOT USED]

1.11. WARRANTY [NOT USED]

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION

3.1. MEETING SCHEDULE

- A. Recurring project meetings will be held on a monthly basis organized by the OWNER. Additional meetings will be held on an as-needed basis.
- B. The OWNER shall coordinate as necessary to establish mutually acceptable schedule for meetings.

3.2. MEETING LOCATION

- A. The OWNER will establish meeting location. To the maximum extent practicable, meetings will be held at the job site.

3.3. PROJECT MEETINGS

A. Attendance:

1. To the maximum extent practicable, assign the same person or persons to represent the CONTRACTOR at project meetings throughout progress of the Work.
2. OWNER, if determined to be required by the ENGINEER.
3. ENGINEER.
4. Subcontractors, materials suppliers, and others may be invited to attend those project meetings in which their aspect of the Work is involved.
5. Others as appropriate to agenda.

B. Minimum Agenda:

1. Review progress of the Work since last meeting, including status of submittals for approval.
2. Review schedule and identify problems which impede planned progress.
3. Develop corrective measures and procedures to regain planned schedule.
4. Review Pay Requests.

3.4. PRE-INSTALLATION CONFERENCES

- A. Where required in individual specification Section, convene a pre-installation conference at project site or other designed location.
- B. Require attendance of parties directly affecting or affected by work of the specific Section.
- C. Notify all parties to attend at least 1 week in advance of meeting.
- D. Review conditions of installation, preparation and installation procedures, and coordination with related work.

END OF SECTION

SECTION 013200 – CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 – GENERAL

1.1. SUMMARY

- A. Drawings and general provisions of the Contract, including Special Conditions, apply to work of this section.
- B. Related Bid Document sections include, but are not necessarily limited to:
 - a. Section A – Bidding Requirements
 - b. Section B – Contract Agreements and Forms
 - c. Section D – General Provisions

1.2. REFERENCES [NOT USED]

1.3. ADMINISTRATIVE REQUIREMENTS

A. Coordination

- 1. Coordinate both the listing and timing of reports and other activities required by provisions of this section and other sections, as to provide consistency and logical coordination between the reports. Maintain coordination and correlation between separate reports by updating at monthly or shorter time intervals. Make appropriate distribution of each report and updated report to all parties involved in the work including the ENGINEER and OWNER. In particular, provide close coordination of the progress schedule, schedule of values, listing of subcontracts, schedule of submittals, progress reports, and payment requests.

B. Schedule

- 1. Gantt-Chart Schedule: Submit a Gant-chart type progress schedule within 10 days after notification of the OWNER's acceptance of Bid. On the schedule, indicate a time bar for each major category or unit of work to be performed at the site, properly sequenced, and coordinated with other elements of work. Show completion of the work sufficiently in advance of the date established for substantial completion of the work.
- 2. Submittal Schedule
 - a. General: Within 10 days after notification of the OWNER's acceptance of Bid, prepare a complete schedule of work-related submittals. This tabulation shall include both those submittals required during the initial 90 days of construction to maintain the orderly progression of the work, and those submittals required early because of long lead time for manufacturer or fabrication. Correlate this submittal schedule with a listing of principal subcontractors, and with the "listing of products" or the "procurement schedule" as specified in "Products and Substitutions" sections and elsewhere in the contract documents.

- b. Form: Prepare the schedule in chronological order of submittals. Show category of the submittal, name of subcontractor, a generic description of the work covered, related section numbers, the activity or event number on the progress schedule, the scheduled date for the first submittal, resubmittal, and the final release or approved by the ENGINEER. Provide with the listing of the subcontractors the corresponding mailing address, business address, telephone number, fax number (if applicable) and contact person.

C. Schedule of Values

1. Submit a detailed Schedule of Values for the Work to be performed on the project.
 - a. Submit schedule within 10 days prior to submitting the first Application for Payment.
 - b. Line items in the Agreement are to be used as line items in the schedule.
 - c. Payment will be made on the quantity of Work completed per Contract Documents during the payment period and as measured per this Section.
 - (i) Payment amount is the Work quantity measured multiplied by the unit prices for that line item in the Agreement.
 - (ii) Payment on a unit price basis will not be made for work outside finished dimensions shown in the Contract Documents.
 - (iii) Partial payments will be made for lump sum line items in the Agreement.
1. Lump sum line items in the Agreement are to be divided into smaller unit prices to allow more accurate determination of the percentage of the item that has been completed.
 - a. Provide adequate detail to allow more accurate determination of the percentage of work completed for each item.
 - b. Provide prices for items that do not exceed \$50,000.00. An exception may be made for equipment packages that cannot be subdivided into units or subassemblies.
 - c. Separate product costs and installation costs.
 - i. Product costs include cost for product, delivery and unloading costs, royalties and patent fees, taxes, and other cost paid directly to the Subcontractor or Supplier.
 - ii. Installation costs include cost for the supervision, labor and equipment for field fabrication, erection, installation, start up, initial operation and Contractor's overhead and profit. For equipment or systems that exceed \$50,000 the costs reported for startup activation shall not be less than 10 percent of the total item cost.
 - d. Lump sum items may be divided into an estimated number of units.

- i. The estimated number of units times the cost per unit must equal the lump sum amount for that line item.
 - ii. Contractor will receive payment for all of the lump sum line item.
 - e. Include a directly proportional amount of Contractor's overhead and profit for each line item.
 - f. Divide principal subcontract amounts into an adequate number of line items to allow determination of the percentage of work completed for each item.
2. These line items may be used to establish the value of work to be added or deleted from the project.
3. Correlate line items with other administrative schedules and forms:
- a. Progress schedule,
 - b. List of Subcontractors,
 - c. Schedule of allowances,
 - d. Schedule of alternatives,
 - e. List of products and principal Suppliers, and
 - f. Schedule of Submittals
4. Costs for mobilization shall be listed as a separate line item and shall be actual cost for:
- a. Bonds and insurance,
 - b. Transportation and setup for equipment,
 - c. Transportation and/or erection of all field offices, sheds and storage facilities,
 - d. Salaries for preparation of submittals required before the first Application for Payment,
 - e. Salaries for field personnel assigned to the project related to the mobilization of the project,
5. The sum of all values listed in the schedule must equal the total contract amount.
- (iv) Submit a schedule indicating the anticipated schedule of payments to be made by the Owner. Schedule shall indicate:
- 1. The Application for Payment number,
 - 2. Date the request is to be submitted, and

3. Anticipated amount of payment to be requested.
 - (v) Update the Schedule of Values quarterly or more often if necessary to provide a reasonably accurate indication of the funds that the Owner will need to have available to make payment to the Contractor for the Work performed.
2. Provide written approval of the Schedule of Values, Application for Payment form, and method of payment by the Surety Company providing performance and payment bonds prior to submitting the first Application for Payment. Payment will not be made without this approval.
3. Payment Requests
 - a. Refer to the General and Special Conditions.
 - b. Application at Time of Final Walk Through: Following issuance of ENGINEER's final punch list, and also in part as applicable to prior certificates on portions of completed work as designated, a "special" payment application may be prepared and submitted by CONTRACTOR. The principal administrative actions and submittals which must precede or coincide with such special applications can be summarized as follows, but not necessarily by way of limitation:
 - (i) Occupancy permits and similar approvals or certifications by governing authorities and franchised services, assuring OWNER's full access and use of completed work.
 - (ii) Warranties (guarantees), maintenance agreements and similar provisions of contract documents.
 - (iii) Test/adjust/balance records, maintenance instructions, meter readings, start-up performance reports, and similar change-over information germane to OWNER's occupancy, use, operation, and maintenance of completed work.
 - (iv) Final cleaning of the work.
 - (v) Listing of CONTRACTOR's incomplete work, recognized as exceptions to ENGINEER's certificate of substantial completion.
 - (vi) As-built plans and record drawings.
 - c. Final Payment Application: The administrative actions and submittals which must precede or coincide preparation of final estimate by ENGINEER can be summarized as follows, but not necessarily by way of limitation:
 - (i) Completion of project closeout requirements.
 - (ii) Completion of items specified for completion beyond time of substantial completion (regardless of whether special payment application was previously made).

- (iii) Assurance, satisfactory to OWNER, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
 - (iv) Transmittal of required project construction records to OWNER.
 - (v) Proof, satisfactory to OWNER, that taxes, fees, and similar obligations of CONTRACTOR have been paid.
 - (vi) Removal of temporary facilities, services, surplus materials, rubbish, and similar elements.
 - (vii) Affidavit that all subcontractors and suppliers have been paid in full.
 - (viii) Consent of surety for final payment.
- d. Application Transmittal: Submit to the ENGINEER waivers of lien and similar attachments. Transmit a form listing those attachments and recording information related to the Final Payment.

1.4. SUBMITTALS [NOT USED]

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6. CLOSEOUT SUBMITTALS [NOT USED]

1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8. QUALITY ASSURANCE [NOT USED]

1.9. DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10. FIELD CONDITIONS [NOT USED]

1.11. WARRANTY [NOT USED]

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION [NOT USED]

END OF SECTION

SECTION 013323 – SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 – GENERAL

1.1. SUMMARY

- A. This section is intended to supplement the General Provisions. Drawings and General Provisions of the Contract, including Special Conditions, apply to work of this section.
 - 1. Refer to General Provisions Section 3.11 in Section D
- B. Related Specification Sections include, but are not necessarily limited to:
 - a. General Provisions in Section D
 - (i) GP 3.11 – Shop Drawings, Product Data and Samples

1.2. DESCRIPTION OF REQUIREMENTS

- A. General: This section specifies procedural requirements for non-administrative submittals including shop drawings, product data, samples, and other miscellaneous work-related submittals. Shop drawings, product data, samples and other work-related submittals are required to amplify, expand, and coordinate the information contained in the Contract Documents.
 - 1. Required administrative, non-work-related submittals include, but are not limited to the following items:
 - (i) Permits.
 - (ii) Payment Applications.
 - (iii) Performance and Payment Bonds.
 - (iv) Insurance Certificates.
 - (v) Inspection and Test Reports.
 - (vi) Schedule of Values.
 - (vii) Excavation Safety Plan.
 - (viii) Trench Safety Plan.
 - (ix) Listing of Subcontractors.
 - (x) Traffic Control Plan.
 - (xi) Stockpile Plan.
 - (xii) List of Anticipated Shop Drawing Submittals
 - (xiii) Asbestos Free Materials Certification Form

- B. Shop Drawings: Shop drawings prepared for this project by the CONTRACTOR including but not limited to the following items:
1. Fabrication and installation drawings.
 2. Pipe restraint plans and calculations.
 3. Setting diagrams.
 4. Shopwork manufacturing instructions.
 5. Templates.
 6. Patterns.
 7. Coordination drawings (for use on-site).
 8. Schedules.
 9. Design mix formulas.
 10. CONTRACTOR's engineering calculations.

Standard information prepared without specific reference to a project is not considered to be shop drawings.

- C. Product data includes standard printed information on manufactured products that has not been specially-prepared for this project by the CONTRACTOR, including but not limited to the 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.
- D. Miscellaneous submittals are work-related, non-administrative submittals that do not fit in the three previous categories, including, but not limited to the following:
1. Specially-prepared and standard printed warranties.
 2. Maintenance agreements.
 3. Workmanship bonds.
 4. Survey data and reports.
 5. Project photographs.
 6. Testing and certification reports.
 7. Record drawings.

8. Field measurement data.
9. Operating and maintenance manuals.
10. Keys and other security protection devices.
11. Maintenance tools and spare parts.
12. Overrun stock.

1.3. SUBMITTAL PROCEDURES

- A. Submit shop drawings, layouts, manufacturer's data, and material schedules as may be required by the ENGINEER for his review in electronic format (PDF). Submittals shall be transmitted either via email or to an ftp site created for the project. The specifics of the submittal process will be finalized during the pre-construction meeting. CONTRACTOR shall also be responsible for providing hard copies of the submittals if requested by the OWNER.
- B. Submittals shall be checked by and stamped with the approval of the CONTRACTOR and identified as the ENGINEER may require.
 1. Such review by the ENGINEER shall include checking for general conformance with the design concept of the project and general compliance with information given in the General Contract Documents.
 2. Indicated actions by the ENGINEER which may result from his review, shall not constitute concurrence with any deviation from the plans and specifications unless such deviations are specifically identified by the method described below, and further shall not relieve the CONTRACTOR of responsibility for errors or omissions in the submitted data.
 3. Processed shop drawing submittals are not change-orders. The purpose of submittals by the CONTRACTOR is to demonstrate that the CONTRACTOR understands the design concept, and that he demonstrates his understanding by indicating which equipment and materials he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. If deviations, discrepancies or conflicts between submittals and the design drawings and/or specifications are discovered, either prior to or after submittals are processed, the design drawings and specifications shall govern.
- C. The CONTRACTOR shall be responsible for dimensions which are to be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of his work with that of other trades and satisfactory performance of his work. The CONTRACTOR shall check and verify all measurements and review submittals prior to being submitted, and sign or initial a statement included with the submittal, which signifies compliance with plans and specifications and dimensions suitable for the application. Any deviation from the specified criteria shall be expressly stated in writing in the submittal. One (1) copies of the approved submittals shall be retained by the CONTRACTOR until completion of the project.
- D. Coordination: Coordinate the preparation and processing of submittals with the performance of the work. Coordinate each separate submittal with other submittals and related activities such as testing, purchasing, fabrication, delivery and similar activities that require sequential activity.

1. Coordinate the submittal of different units of interrelated work so that one submittal will not be delayed by the ENGINEER's need to review a related submittal. The ENGINEER reserves the right to withhold action on any submittal requiring coordination with other submittals until related submittals are forthcoming.
- E. Coordination of Submittal Times: Prepare and transmit each submittal to the ENGINEER sufficiently in advance of the scheduled performance of related work and other applicable activities. Transmit different kinds of submittals for the same unit of work so that processing will not be delayed by the ENGINEER's need to review submittals concurrently for coordination.
- F. Review Time: Allow sufficient time so that the installation will not be delayed as a result of the time required to properly process submittals, including time for resubmittal, if necessary. Advise the ENGINEER on each submittal, as to whether processing time is critical to the progress of the work and if the work would be expedited if processing time could be shortened.
 1. For scheduling purposes, CONTRACTOR shall assume a two-week turnaround between the time the submittal is received by the ENGINEER and when final comments are returned.
- G. Submittal Preparation: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the CONTRACTOR to the ENGINEER, and to other destinations as indicated, by use of a transmittal form. Submittals received from sources other than the CONTRACTOR will not be returned to the sender and no action will be taken by the ENGINEER. Provide the following information on the cover sheet for proper processing and recording of action taken.
 1. Project name.
 2. Date.
 3. Name and address of ENGINEER.
 4. Name and address of CONTRACTOR.
 5. Name and address of Subcontractor, Supplier, and Manufacturer.
 6. Number and title of appropriate specification section.
 7. Drawing number and detail references, as appropriate.
 8. Similar definitive information as necessary.
 9. Submittal and transmittal distribution record.
 10. Signature of transmitter.
11. Each submittal shall have a stamp, signed by the CONTRACTOR, conforming with General Conditions 3.11.5.2. Record relevant information and requests for data on the transmittal form. On the transmittal form, or on a separate sheet attached to the form, record deviations from the requirements of the Contract Documents, if any, including minor variations and limitations.

- H. Submittal Organization: Submittals shall be organized in such a way as to group like items together. At a minimum, submittals shall not incorporate multiple sections into a single submittal. Submittals not meeting this requirement will be rejected. Additionally, partial submittals will not be approved.

1.4. SPECIFIC SUBMITTAL REQUIREMENTS

- A. General: Specific submittal requirements for individual units of work are specified in the applicable specification section. Except as otherwise indicated in the individual specification sections, comply with the requirements specified herein for each type of submittal.
 - 1. Where it is necessary to provide intermediate submittals between the initial and final submittals, provide and process intermediate submittals in the same manner as for initial submittals.
- B. Shop Drawings: Information required on shop drawings includes dimensions, identification of specific products and materials which are included in the work, compliance with specified standards, and notations of coordination requirements with other work. Provide special notation of dimensions that have been established by field measurement. Highlight, encircle or otherwise indicate deviations from the contract documents on the shop drawings.
 - 1. Coordination Drawings: Provide coordination drawings where required for the integration of the work, including work first shown in detail on shop drawings or product data. Show sequencing and relationship of separate units of work, which must interface in a restricted manner to fit in the space provided, or function as indicated. Coordination drawings are considered shop drawings and must be definitive in nature.
 - 2. Do not permit shop drawing copies without an appropriate final "Action" marking by the ENGINEER to be used in connection with the work.
- C. Product Data: General information required specifically as product data includes manufacturer's standard printed recommendations for application and use, compliance with recognized standards of trade associations and testing agencies, and the application of their labels and seals (if any), special notation of dimensions which have been verified by way of field measurement, and special coordination requirements for interfacing the material, product, or system with other work.
 - 1. Preparation: Collect required product data into a single submittal for each unit of work or system. Mark each copy to show which choices and options are applicable to the project. Where product data has been printed to include information on several similar products, some of which are not required for use on the project, or are not included in this submittal, mark the copies to show clearly that such information is not applicable.
 - a. Where product data must be specially prepared for required products, materials, or systems, because standard printed data is not suitable for use, submit data as "shop drawings" and not as "product data".
 - 2. Submittals:

- a. Product data submittal is required for information and record and to determine that the products, materials, and systems comply with the provisions of the contract documents. Therefore, the initial submittal is also the final submittal, except where the ENGINEER observes that there is non-compliance with the provisions of the contract documents and returns the submittal promptly to the CONTRACTOR marked with the appropriate "Action".
 - b. Do not submit product data or allow its use on the project, until compliance with the requirements of the contract documents has been confirmed by the CONTRACTOR.
 3. Installation Copy: Do not proceed with installation of materials, products, and systems until a copy of product data applicable to the installation is in the possession of the installer. Do not permit the use of unmarked copies of product data in connection with the performance of the work.
- D. Miscellaneous Submittals:
1. Inspection and Test Reports: Classify each inspection and test report as being either "shop drawing" or "product data" depending on whether the report is specially prepared for the project, or a standard publication of workmanship control testing at the point of production. Process inspection and test reports accordingly.
 2. Warranties: Refer to section "Substitutions and Product Options" for specific general requirements on warranties, product bonds, workmanship bonds and maintenance agreements. In addition to copies desired for the CONTRACTOR's use, furnish 2 executed copies of such warranties, bonds, or agreements. Provide 2 additional copies where required for maintenance manuals.
 3. Standards: Where submittal of a copy of standards is indicated, and except where copies of standards are specified as an integral part of a "Product Data" submittal, submit a single copy of standards for the ENGINEER's use. Where workmanship, whether at the project site or elsewhere is governed by a standard, furnish additional copies of the standard to fabricators, installers and others involved in the performance of the work.
 4. Closeout Submittals: Refer to section "Contract Closeout" and to individual sections of these specifications for specific submittal requirements of project closeout information, materials, tools, and similar items.
 5. General Distribution: Provide additional distribution of submittals to governing authorities, and others as necessary for the proper performance of the work. Include such additional copies of submittals in the transmittal to the ENGINEER where the submittals are required to receive "Action" marking before final distribution. Record distributions on transmittal forms.
 6. Stockpile Plan: The CONTRACTOR shall submit a "Stockpile Plan" that designates locations for temporary storage of excavated pavement and soil. This plan is subject to approval by the OWNER. The CONTRACTOR shall submit a Stockpile Plan that outlines the materials to be incorporated into the project.

7. Traffic Control Plan: The CONTRACTOR shall submit a Traffic Control Plan that outlines how ingress and egress requirements will be adhered to in conjunction with the sequence of the work.
8. Trench Safety Plan: The CONTRACTOR shall submit a Trench Safety Plan.
9. Telephone Numbers: The CONTRACTOR shall submit telephone numbers of the Project Manager, Superintendent, Foreman, and individual(s) authorized to verify the monthly pay estimate.
10. Storm Water Pollution Plan: The CONTRACTOR shall submit a Storm Water Pollution Plan (if required) in accordance with Section 015723, TEMPORARY STORM WATER POLLUTION CONTROL.
11. Competent person as defined by OSHA.
12. Name of Safety Representative.

1.5. ENGINEER'S ACTION

- A. General: Except for submittals for the record and similar purposes, where action and return on submittals is required or requested, the ENGINEER will review each submittal, mark with appropriate "Action", and return. Where the submittal must be held for coordination, the ENGINEER will so advise the CONTRACTOR.
 1. Action Stamp: The ENGINEER will stamp each submittal to be returned with a uniform, self-explanatory action stamp, appropriately marked and executed to indicate whether the submittal returned is for unrestricted use (no exceptions taken), final-but-restricted use (exceptions noted), must be revised and resubmitted (use not permitted) or without action (as explained on the transmittal form).

1.6. ENGINEER REVIEW REIMBURSEMENT

- A. CONTRACTOR shall furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than two submittals; original and one resubmittal. As provided in General Conditions 3.11.5.1, ENGINEER will record ENGINEER's time for reviewing subsequent submittals of Shop Drawings, samples, or other items requiring approval and CONTRACTOR shall reimburse OWNER for ENGINEER's charges for such time.
- B. In the event that CONTRACTOR requests a change of a previously approved item, CONTRACTOR shall reimburse OWNER for ENGINEER's charges for its review time, with minimum of \$1,000, unless the need for such change is beyond the control of CONTRACTOR.
- C. Compensation to ENGINEER for review of substitutions, designs related to correction of defective Work, or other Services identified as requiring payment by the CONTRACTOR will be based on rates previously agreed with the County of San Bernardino, Special Districts.
- D. Engineering cost for excessive review of shop drawings will be paid by the CONTRACTOR.
 1. Excessive review of shop drawings is defined as any review required after the original review has been made and the first resubmittal has been checked to confirm that appropriate corrections have been made.

2. Cost for additional review time will be billed to the OWNER by the ENGINEER for the actual hours required for the review and marking of shop drawings by ENGINEER and in accordance with the rates listed above.
3. Pay cost for the additional review to the OWNER on a monthly basis as billed by the OWNER.
4. Need for more than one resubmission or any other delay of obtaining ENGINEER's review of submittals, will not entitle the CONTRACTOR to an extension of Contract Time. All costs associated with such delays shall be at the CONTRACTOR's expense.

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION [NOT USED]

END OF SECTION

SECTION 013516 – ALTERATION PROJECT PROCEDURES

PART 1 – GENERAL

1.1. SUMMARY

- A. Section includes: Requirements and procedures for performing alterations to existing facilities.
- B. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.2. SUBMITTALS

- A. Alterations schedule: Submit in accordance with requirements for Progress Schedules.

1.3. SEQUENCE AND SCHEDULES

- A. Perform Work in sequences and within times specified in General Provisions.
- B. Submit separate detailed sub-schedule for alterations, coordinated with construction schedules. Indicate:
 - 1. Each stage of Work and dates of occupancy of areas.
 - 2. Date of Substantial Completion for each area of alterations as appropriate.
 - 3. Trades and Subcontractors employed in each stage.

1.4. WORK INVOLVED WITH EXISTING OPERATING FACILITIES

- A. Perform the Work while existing facility is in operation.
- B. Do not jeopardize operation or materially reduce efficiency of existing facility.
- C. Coordinate the Work with operation of the facility:
 - 1. Do not begin alterations of designated portions of the Work until specific permission has been granted in writing by OWNER in each case.
 - 2. ENGINEER will coordinate the planned procedure with facility manager.
 - 3. Complete as quickly as possible and with as little delay as possible,
 - 4. Connections to existing equipment and utilities, and other operations that interfere with the operation of existing facility.
- D. Operational functions of the facility that are required to be performed to facilitate the Work will be performed by facility personnel only.
- E. Plant Superintendent will cooperate in every way practicable to assist in expediting the Work.

- F. When necessary for the proper operation or maintenance of portions of the facility, reschedule Work operations so that the Work will not conflict with necessary operations or maintenance of the facility.

1.5. ALTERATIONS, CUTTING, AND PROTECTION

- A. Assign relocation, removal, cutting, and patching to trades qualified to perform in manner which causes least damage and provide means of returning surfaces to appearance of new construction.
- B. Provide weather protection, waterproofing, heat, and humidity control as needed to prevent damage to remaining existing and new construction.

1.6. SALVAGE MATERIALS

- A. Salvage materials: Materials removed from existing facility shall be salvaged for OWNER's use if noted on the plans.

1.7. PREPARATION

- A. Identify existing materials which shall be patched, extended, or matched.
- B. In addition to demolition construction specifically indicated on the Drawings, cut, move, or remove items as necessary to provide access or to allow alteration and new construction to proceed, including:
 - 1. Repair or removal of hazardous or unsanitary conditions.
 - 2. Removal of abandoned items and items serving no useful purpose, such as abandoned piping, conduit, and wiring.
 - 3. Removal of unsuitable or extraneous materials not marked for salvage, such as abandoned furnishings and equipment, and debris such as rotted wood, rusted metals, and deteriorated concrete.
 - 4. Cleaning of surfaces and removal of surface finishes needed to install new construction and finishes.
 - 5. Disposal of items removed and not salvaged.
- C. Cut and remove minimum amount of existing construction in manner which avoids damage to adjacent work.
- D. Cut finish surfaces such as masonry, tile, plaster, and metals by methods which terminate surfaces in straight line at natural points of division.

1.8. TRANSITION FROM EXISTING TO NEW WORK

- A. When new construction abuts or finishes flush with existing construction, make smooth transitions and match architecture of existing construction.
- B. Where partitions are removed, patch floors, walls, and ceilings with finish materials which match existing materials.
- C. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth planes without breaks, steps, or bulkheads.
- D. Where changes of plane exceed 2 inches, request instructions for making transition.
- E. Trim and refinish existing doors as necessary to clear new floors.

- F. Match patched construction with adjacent construction in texture and appearance so that patch or transition is invisible at 5-foot distance.
- G. When finished surfaces are cut so that smooth transition is impossible, terminate existing surface in neat manner along straight line at natural line of division and provide appropriate trim.

1.9. DAMAGED SURFACES

- A. Patch and replace portions of existing finished surfaces which are damaged, lifted and discolored with matching material.
- B. Provide adequate support of substrate prior to patching finishes.
- C. Refinish patched portion of painted or coated surfaces in manner which produces uniform color and texture to entire surface.
- D. When existing surface finish cannot be matched, refinish entire surface to nearest change of plane exceeding 45 degrees.

1.10. CLEANING

- A. Perform periodic and final cleaning as specified in General Provisions.
- B. Clean owner-occupied areas daily.
- C. Clean spillage, overspray, and heavy collection of dust in owner-occupied areas immediately.
- D. At completion of each portion of Work, clean area and make surfaces ready for successive portions of Work.
- E. At completion of alterations in each area, provide final cleaning and return space to condition suitable for use by OWNER.

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION [NOT USED]

END OF SECTION

SECTION 014000 – QUALITY REQUIREMENTS

PART 1 – GENERAL

1.1. CONTRACTOR'S QUALITY CONTROL RESPONSIBILITIES

- A. Control the quality of the Work and verify that the Work meets the standards of quality established in the Contract Documents.
 - a. Inspect the Work of the Contractor, Subcontractors and Suppliers. Correct defective Work.
 - b. Inspect products and materials to be incorporated into the Project. Ensure that Suppliers of raw materials, parts, components, assemblies, and other products have adequate quality control system to ensure that quality products are produced. Provide only products that comply with the Contract Documents.
 - c. Provide and pay for the services of an approved professional materials testing laboratory acceptable to the Owner to assure that products proposed for use fully comply with the Contract Documents.
 - d. Provide all facilities and calibrated equipment required for quality control tests.
 - e. Provide consumable construction materials of adequate quality to provide a finished product that complies with the Contract Documents.
 - f. Perform tests as indicated in this and other sections of the specifications. All quality control testing is to be observed by the Owner's designated representative.
 - g. Maintain complete inspection and testing records at the site and make them available to Owner or Engineer.
- B. Designate a quality control manager before Work begins with authority to monitor the work effectively and to prepare implement and enforce a Quality Management Plan.
- C. Provide and pay for the services of an approved professional materials testing laboratory acceptable to the Owner to assure that Work fully complies with the Contract Documents. Provide services of a testing laboratory capable of performing a full range of testing procedures complying with the standards for testing procedures specified. Provide personnel certified to perform the test required. Obtain Owners' approval for the testing laboratory before testing is performed. All certified test results shall be delivered directly to the Owner and the Engineer.
- D. Should requirements of this Section of the specification conflict with the requirements of the technical specifications, the technical specifications shall govern.

1.2. QUALITY ASSURANCE ACTIVITIES BY THE OWNER

- A. Owner may perform its own quality assurance test independent of the Contractor's Quality Control Program or as otherwise described in the Contract Documents. Provide labor, materials, tools, equipment, and related items for testing by the Owner including, but not limited to temporary construction required for testing and operation of new and existing utilities. Assist the Owner or Engineer, and testing organizations in performing quality assurance activities.

1. Provide access to the Work and to the Supplier's operations at all times Work is in progress.
 2. Cooperate fully in the performance of sampling, inspection, and testing.
 3. Furnish labor and facilities to:
 - a. Provide access to the work to be tested.
 - b. Obtain and handle samples for testing at the project site or at the source of the product to be tested.
 - c. Provide calibrate scales and measuring devices for the Owner's use.
 - d. Facilitate inspections and tests.
 - e. Provide adequate lighting to allow Owner observations.
 - f. Store and cure test samples.
 4. Furnish copies of the tests performed on materials and products.
 5. Provide adequate quantities of representative product to be tested to the laboratory at the designated location.
 6. Give the Owner's Designated Representative adequate notice before proceeding with work that would interfere with testing.
 7. Notify the Owner's Designated Representative and the testing laboratory prior to the time that testing is required. Lead time is to be adequate to allow arrangements to be made for testing.
 8. Do not proceed with any work until testing services have been performed and results of tests indicate that the work is acceptable.
 9. Provide complete access to the Site and make Contract Documents available.
 10. Provide personnel and equipment needed to perform sampling or to assist in making the field tests.
 11. Quality Assurance testing performed by the Owner will be paid for by the Owner, except for verification testing performed by the Owner, which shall be paid for by the Contractor as described in Paragraph 1.06.
- B. Quality Assurance activities of the Owner or Engineer through their own forces or through contracts with materials testing laboratories and survey crews are for the purpose of monitoring the results of the Contractor's work to see that it is in compliance with the requirements of the Contract Documents.
- C. Quality assurance activities of the Owner and Engineer or non-performance of quality assurance activities:
1. Do not relieve the Contractor of its responsibility to perform Work and furnish materials and products and constructed Work conforming to the requirements of the Contract Documents.
 2. Do not relieve the Contractor of its responsibility for providing adequate quality control measures.

3. Do not relieve the Contractor of responsibility for damage to or loss of the material, product or Work before Owner's acceptance.
 4. Do not constitute or imply Owner's acceptance.
 5. Do not affect the continuing rights of the Owner after Owner's acceptance of the completed Work.
- D. The presence or absence of the Owner's Resident Representative or Engineer does not relieve the Contractor from any contract requirement, nor is the Owner's Resident Representative or Engineer authorized to change any term or condition of the Contract Documents without the Owner's written authorization in a Field Order or Change Order.
- E. Failure on the part of the Owner or Engineer to perform or test products or constructed works in no way relieves the Contractor of the obligation to perform work and furnish materials conforming to the Contract Documents.
- F. All materials and products are subject to Owner's quality assurance observations or testing at any time during preparation or use. Material or products which have been tested or observed or approved by Owner at a supply source or staging area may be re-observed or re-tested by Owner before or during or after incorporation into the Work, and rejected if they do not comply with the Contract Documents

1.3. SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 23, SUBMITTALS, and shall include:
1. A written Quality Management Plan that establishes the methods of assuring compliance with the Contract Documents. Submit this program as Record Data
 2. A Statement of Qualification for the proposed testing laboratory. The statement of qualifications is to include a list of the engineers and technical staff that will provide testing services on the Project, descriptions of the qualifications of these individuals, list of tests that can be performed, equipment used with date of last certification and a list of recent projects for which testing has been performed with references for those projects.
 3. Test reports per Paragraph 1.07, TEST REPORTS of this specification. Reports are to certify that products or constructed Works are in full compliance with the Contract Documents or indicate that they are not in compliance and describe how they are not in compliance.
 4. Provide Certified Test Reports on materials or products to be incorporated into the Project. Reports are to indicate that material or products are in full compliance with the Contract Documents or indicate that they are not in compliance and describe how they are not in compliance.

1.4. STANDARDS

- A. Provide a testing laboratory that complies with the ACIL (American Council of Independent Laboratories) "Recommended Requirements for Independent Laboratory Qualifications".

- B. Perform testing per recognized test procedures as listed in the various sections of the specifications, standards of the State Department of Highways and Public Transportation, American Society of Testing Materials (ASTM), or other testing associations. Perform tests in accordance with published procedures for testing issued by these organizations.

1.5. DELIVERY AND STORAGE

- A. Handle and protect test specimens of products and construction materials at the Site in accordance with recognized test procedures.

1.6. VERIFICATION TESTING

- A. Provide verification testing when tests indicate that materials or the results of construction activities are not in conformance with Contract Documents.
- B. Verification testing is to be provided at the Contractor's expense to verify products or constructed works are in compliance after corrections have been made.
- C. Tests must comply with recognized methods or with methods recommended by the testing laboratory and approved by the Engineer.

1.7. TEST REPORTS

- A. Test reports are to be prepared for all tests.
 - 1. Tests performed by testing laboratories may be submitted on their standard test report forms. These reports must include the following:
 - a. Name of the Owner, project title and number, equipment installer and general contractor.
 - b. Name of the laboratory, address, and telephone number.
 - c. Name and signature of the laboratory personnel performing the test.
 - d. Description of the product being sampled or tested.
 - e. Date and time of sampling, inspection, and testing.
 - f. Date the report was issued.
 - g. Description of the test performed.
 - h. Weather conditions and temperature at time of test or sampling.
 - i. Location at the site or structure where the test was taken.
 - j. Standard or test procedure used in making the test.
 - k. A description of the results of the test.
 - l. Statement of compliance or non-compliance with the Contract Documents.
 - m. Interpretations of test results, if appropriate.
 - 2. Submit reports on tests performed by Contractor or his suppliers or vendors in the Contractor's standard format, as approved by Owner.
 - 3. Engineer will prepare test reports on test performed by the Engineer.

- B. Distribute copies of the test reports to the Owner's Designated Representative within 24 hours of completing the test. Flag tests reports with results that do not comply with Contract Documents for immediate attention. Payment for Work subject to testing may be withheld until the Contractor's quality control test reports of the Work are submitted to the Owner's Resident Representative.

1.8. NON-CONFORMING WORK

- A. Immediately correct any Work that is not in compliance with the Contract Documents or submit a written explanation of why the Work is not to be corrected immediately and when corrective to the Work will be performed.
- B. Payment for non-conforming Work shall be withheld until Work is brought into compliance with the Contract Documents.

1.9. LIMITATION OF AUTHORITY OF THE TESTING LABORATORY

- A. The testing laboratory representatives are limited to providing consultation on the test performed and in an advisory capacity.
- B. The testing laboratory is not authorized to:
 - 1. Alter the requirements of the Contract Documents.
 - 2. Accept or reject any portion of the Work.
 - 3. Perform any of the duties of the Contractor.
 - 4. Stop the work.

1.10. QUALITY CONTROL PLAN

- A. Submit Contractor's Quality Control Plan that identifies personnel, procedures, control, instructions, tests, records, and forms to be used. Construction will be permitted to begin only after acceptance of the Quality Control Plan or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a Quality Control Plan or another interim plan containing the additional features of work to be started.
- B. Content of the Quality Control Plan. The Quality Control Plan shall include, as a minimum, the following to address all construction operations, both onsite and offsite, including work by Subcontractors and Suppliers:
 - 1. A description of the quality control organization, including a chart showing lines of authority and acknowledgement that the quality control staff shall implement the quality control program for all aspects of the Work specified.
 - 2. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a quality control function.

3. A copy of the letter to the Quality Control Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the Quality Control Manager, including authority to stop work which does not comply with the Contract Documents or will result in Work that does not comply with the Contract Documents. The Quality Control Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Owner's Designated Representative.
 4. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of Subcontractors and Suppliers.
 5. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, person responsible for each test, applicable industry testing standards and laboratory facilities to be used for the test.
 6. Procedures for tracking phases of quality control, verification, and acceptance tests including documentation.
 7. Procedures for tracking construction deficiencies from identification through acceptable corrective action. Indicate how verification that identified deficiencies have been corrected is to be documented.
 8. Reporting procedures, including proposed reporting formats
 9. The name of the proposed testing laboratory along with documentation of qualifications, a list of tests that can be performed, and a list of recent projects for which testing has been performed with references from those projects.
- C. Notification of Changes. After submittal of the Quality Control Plan, the Contractor shall notify the Owner in writing of any proposed changes.
- D. Coordination Meeting. After the Pre-construction Meeting and before start of construction, the Contractor shall meet with the Owner or Engineer to discuss the Contractor's Quality Control Plan. The Quality Control Plan shall be submitted a minimum of fourteen (14) calendar days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the Quality Control operations, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's management and control with the Owner's Quality Assurance. Revise the Quality Management Plan to reflect comments and recommended changes resulting from this meeting.

PART 2 – PRODUCTS

2.1. TESTING APPARATUS

- A. Furnish testing apparatus and related accessories necessary to perform the tests.

PART 3 – EXECUTION

3.1. QUALITY CONTROL PROGRAM

- A. Perform quality control observations and testing as required in each section of the specifications and where indicated on the drawings.
- B. Provide a quality control program that includes the following phases for each definable Work task. A definable Work task one which is separate and distinct from other tasks, has separate control requirements, may be provided by different trades or disciplines, or may be work by the same trade in a different environment.
 - 1. Planning Phase. Perform the following before beginning each definable Work task:
 - a. Review the contract drawings.
 - b. Review submittals and determine that they are complete in accordance with the Contract Documents.
 - c. Check to assure that all materials and/or equipment have been tested, submitted, and approved.
 - d. Examine the work area to assure that all required preliminary work has been completed and is in compliance with the Contract Documents.
 - e. Examine required materials, equipment, and sample work to assure that they are on hand, conform to submittals, and are properly stored.
 - f. Review requirements for quality control inspection and testing.
 - g. Discuss procedures for controlling quality of the work. Document construction tolerances and workmanship standards for the Work task.
 - h. Check that the portion of the plan for the Work to be performed incorporates submittal comments.
 - i. Discuss results of planning with the Owner's Designated Representative. Conduct a meeting attended by the quality control manager, the Owner's Designated Representative, superintendent, other quality control personnel as applicable, and the foreman responsible for the Work task. Instruct applicable workers as to the acceptable level of workmanship required in order to meet the requirements of the Contract Documents. Document the results of the preparatory phase actions by separate meeting minutes prepared by the quality control manager and attached to the quality control report.
 - j. Do not move to the next phase unless results of investigations required for the planning phase indicate that requirements have been met.
 - 2. Work Phase. Complete this phase after the Planning Phase:
 - a. Notify the Owner's Designated Representative at least 24 hours in advance of beginning the Work and discuss the review of the planning effort to indicate that requirements have been met.
 - b. Check the Work to ensure that it is in full compliance with the Contract Documents.
 - c. Verify adequacy of controls to ensure full compliance with Contract Documents. Verify required control inspection and testing is performed.
 - d. Verify that established levels of workmanship meet acceptable workmanship standards. Compare with required sample panels as appropriate.

- e. Repeat the initial phase for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
 - 3. Follow-up Phase. Perform daily checks to assure control activities, including control testing, are providing continued compliance with contract requirements:
 - a. Make checks daily and record observations in the quality control documentation.
 - b. Conduct follow-up checks to correct all deficiencies prior to the start of additional Work tasks that may be affected by the defective Work. Do not build upon nor conceal non-conforming work.
 - c. Conduct a review of the Work one month prior to the expiration of the correction period prescribed in the General Conditions with the Owner. Correct defects noted during the review.
 - C. Conduct additional planning and review if:
 - 1. The quality of on-going work is unacceptable
 - 2. Changes are made in applicable quality control staff, onsite production supervision or work crew
 - 3. Work on a task is resumed after a substantial period of inactivity
 - 4. Other quality problems develop.
- 3.2. CAST-IN-PLACE CONCRETE TESTING
- A. Test cast-in-place concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.
- 3.3. PROTECTIVE COATINGS
- A. Test protective coatings per Section 09 96-00, PROTECTIVE COATINGS and Section 09 91 00, PAINTING
- 3.4. LEAKAGE TESTS FOR STRUCTURES
- A. Test structures that will contain water on a full time or intermittent basis for leaks. Perform tests prior to installing equipment or materials within the structure. In the event that the structure fails to pass the test, drain the structure, repair the leaks, re-fill, and re-test the structure. Repeat tests until the structure passes the test. The Owner may repeat the test at any time during the correction period established in the General Conditions.
 - B. Test the structure for leakage using the following procedure:
 - 1. Determine the evaporation allowance for loss of water.
 - a. Use a standard circular pan procedure established by the U.S. Weather Bureau to measure evaporation rate.
 - b. Calculate evaporation allowance by multiplying the evaporation rate in gallons per 24 hours per square foot of surface area by the open surface area of the water in the structure.
 - 2. Calculate the allowable leakage for the structure. Allowable leakage is calculated as 0.03 gallons per square foot of concrete area in contact with the water per 24 hours.
 - 3. Fill the structure to the overflow level with water at a rate not to exceed 2 feet per hour.

4. Allow the structure to set for three (3) days.
 5. Observe the perimeter of the structure and identify all leaks.
 6. Repair structure walls and floors where leaks have been identified.
 7. Mark the water level at the structure wall. Measure the fall in water level over a 24-hour period to the nearest 1/8" at least twice a day to determine the quantity of water lost. Provide a stilling well for measurement if required to allow accurate measurement.
 8. Calculate the amount of water lost during this time period.
 9. Compare the amount of water lost to the allowable loss.
- C. Drain the structure, determine the sources of leakage and repair if the amount of water lost exceeds the allowable leakage plus the evaporation allowance.

3.5. PIPING SYSTEMS

A. TEST REQUIREMENTS

1. Perform test on piping systems including piping installed between or connected to existing pipe.
2. Conduct tests on buried pipe to be hydrostatically tested after the trench is completely backfilled. If field conditions permit and if approved by the Engineer, partially backfill the trench and leave the joints open for inspection and conducting of the initial service leak test. Do not conduct the acceptance test until backfilling is complete.
3. Pneumatically test the buried piping and expose joints of the buried piping for the acceptance test.
4. Conduct the test on exposed piping after the piping is completely installed, including supports, hangers, and anchors, but prior to insulation and coating application.
5. Do not perform testing on pipe with concrete thrust blocking until the concrete has cured at least five (5) days.
6. Determine and remedy the cause of the excessive leakage for any pipe failing to meet the specified requirements for water or air tightness.
7. Tests must be successfully completed and reports filed before piping is accepted.
8. Submit a comprehensive plan and schedule for testing to the Engineer for review at least 10 days prior to starting each type of testing.
9. Remove and dispose of temporary blocking material and equipment after completion and acceptance of the piping test.
10. Repair any damage to the pipe coating.
11. Clean pipelines so they are totally free flowing prior to final acceptance.
12. Test piping independently from tests on structures.
13. Test method and test pressure depend upon the application of the piping.
 - a. Pressure pipe is defined as piping that is part of a pumped or pressurized system. Perform test for pressure pipe per the procedures indicated in Paragraph B of this section.

- b. Gravity pipe is defined as piping that depends upon the force of gravity for flow through the pipe, with the exception of process piping described in paragraph d. Perform test for gravity pipe per the procedures indicated in Paragraph C, D, or E of this section.
- c. Chemical processing lines are to be tested as pressure pipe regardless of the operating conditions. The test pressure is to be 1.5 times the pressure rating of the pipe.
- d. Process piping between hydraulic structures is to be considered as pressure pipe. Perform the test for this pipe per Paragraph B of this section. The test pressure is to be the maximum hydrostatic head plus 10'. The maximum hydrostatic head is the difference in elevation of the pipe at its lowest point and the maximum top of the wall

B. PRESSURE AND LEAKAGE TESTS OF PRESSURE PIPING

1. Perform hydrostatic pressure and leakage tests using methods, and per performance requirements of Section 5 of AWWA C-600 regardless of pipe material tested.
 - a. The pressure required for hydrostatic pressure test shall be 50% above the normal working pressure at the lowest elevation of the test section except for PVC and HDPE pipe. If the normal working pressure cannot be determined, use the pipe pressure rating as the test pressure. Testing should never exceed the pipe pressure rating for flexible pipe such as PVC and HDPE.
 - b. Provide temporary plugs and blocking necessary to maintain the required test pressure. Where piping is cast in the walls for a structure, brace the walls prior to testing as required to prevent load of test pressure from being imposed upon the structure.
 - c. Provide corporation cocks at least 3/4" in diameter, pipe riser, and angle globe valves at each pipe dead-end in order to bleed air from the line.
 - d. Duration of pressure test shall be at least [4] hours.
 - e. Repair any visible leaks regardless of the total leakage shown by the test.
 - f. Repair pipelines which fail to meet the test and retest as necessary until the results conform to the test requirements.
 - g. Remove and replace defective materials, pipes, valves, and accessories.
 - h. Test the pipelines in sections by shutting valves or installing temporary plugs as necessary.
 - i. Fill the pipeline with water and remove the air.
 - j. Maintain the test pressure in the pipe for the entire test period by means of a force pump.
 - k. Accurately measure the water required to maintain the pressure. The amount of water required is a measure of the leakage.
2. The maximum allowable leakage is determined by the following formula:

$$L = \frac{SD(P)^{1/2}}{F}$$

Equation Term	Represents	Measure
L	Maximum allowable leakage	gallons per hour
S	Length of pipe tested	feet
D	Nominal diameter of the pipe	inches
P	Test pressure	pounds per square inch gauge
F	Pipe factor	
	Use 148,000 Ductile Iron Pipe and PVC Pipe.	
	Use 133,200 for all other pipe types.	

Leakage is defined as the volume of water provided to maintain the test pressure after the pipe has been filled with water, the air expelled and the pipe brought to test pressure.

- Pipe with visible leaks or leakage exceeding the maximum allowable leakage is considered defective and must be corrected.

C. HYDROSTATIC LEAK TEST-GRAVITY FLOW SEWER LINES

- Perform hydrostatic leak tests after backfilling.
- The length of the pipe to be tested shall be such that the head over the crown of the upstream end is not less than 2' or 2' above the ground water level whichever is higher and the head over the downstream crown is not more than 6'.
- Plug the pipe by pneumatic bags or mechanical plugs so that the air can be released from the pipe while it is being filled with water.
- Continue the test for one hour and make provisions for measuring the amount of water required to maintain the water at a constant level during this period.
- Remove the jointing material, and remake the joint if any joint shows any visible leakage or infiltration.
- Remove and replace any defective or broken pipes.
- Determine the maximum allowable leakage or infiltration by the following formula:

$$L = \frac{CDS}{26,720}$$

Equation Term	Represents	Measure
L	Maximum allowable leakage	gallons per hour
S	Length of pipe tested	feet
D	Nominal diameter of the pipe	inches
C	Infiltration / exfiltration rate	
	Use 50 for C outside of 25 year floodplain.	
	Use 10 for C within 25 year floodplain.	

8. Determine the rates of infiltration by means of V-Notch weirs, pipe spigot, or plugs in the end of the pipe. Methods, times, and locations are subject to the Engineer's approval.
 9. Pipe with visible leaks or infiltration or exceeds the maximum allowable leakage or infiltration is considered defective and must be corrected.
- D. LOW PRESSURE AIR TEST- GRAVITY FLOW SEWER LINES
1. Use air test in lieu of the hydrostatic test if desired, or if pipeline grades do not allow filling the entire pipeline segment or manhole to the indicated depth.
 2. Perform low-pressure air tests, using equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. Test is to conform to procedure described in ASTM F-1417 except for testing times. The following test times are required:

Pipe Diameter (inches)	Minimum Time (seconds)	Length for Minimum Time (feet)	Time for Long Length (seconds)
6	340	398	0.855 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.419 (L)
15	850	159	5.342 (L)
18	1020	133	7.693 (L)
21	1190	114	10.471 (L)
24	1360	100	13.676 (L)
27	1530	88	17.309 (L)
30	1700	80	21.369 (L)
33	1870	72	25.856 (L)

- a. Provide the equipment with an air regulator valve or air safety valve set to an internal air pressure in the pipeline that cannot exceed 6 psig.
 - b. Pass air through a single control panel.
 - c. Provide pneumatic plugs that have a sealing length equal to or greater than the circumference of the pipe to be tested.
 - d. Provide pneumatic plugs that resist internal test pressures without requiring external bracing or blocking.
 - e. Provide an air compressor of adequate capacity for charging the system.
3. Perform air test only on lines less than 36" diameter. Air tests for pipes larger than 36" may be air tested at each joint.
 4. Check connections for leakage with a soap solution. Release the air pressure, repair the leak, and retest with soap solution until results are satisfactory, before resuming air test if leaks are found,.
 5. Determine the shortest allowable time for the pressure to drop from 3.5 pounds per square inch to 2.5 pounds per square inch by the following formula:

$$T = 0.0850 DK/Q$$

Equation Term	Represents	Measure
T	Time for the pressure to drop 1.0 pound per square inch gauge	seconds
K	Factor equal to 0.000419DL, but not less than 1.0	
D	Average inside diameter of the pipe	inches
L	Length of line of the same pipe size	feet
Q	Rate of loss. Use 0.0015 cubic feet per minute per square foot of internal surface	

E. AIR TEST FOR INDIVIDUAL JOINTS

1. Lines 36" and larger may be tested at individual joints.
2. The shortest allowable time for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge is 10 seconds for all pipe sizes.

F. DEFLECTION TESTING FOR PIPE

1. Perform deflection tests on flexible and semi-rigid pipe in accordance with ASTM 3034.
 - a. The maximum allowable deflection of pipe measured as the reduction in vertical inside diameter is 5.0% unless specified otherwise.
 - b. Conduct test after the final backfill has been in place a minimum of 30 days.
 - c. Thoroughly clear the lines before testing.
2. Perform test by pulling a properly sized mandrel through the line
3. Excavate and repair pipe with deflections in excess of the maximum allowable deflection.

G. MANHOLE TESTING

Test manholes for leakage separately and independently of the wastewater lines by hydrostatic exfiltration testing, vacuum testing or other approved methods acceptable to TCEQ. Test manholes after installation with all connections (existing and/or proposed) in place. Plug lift holes with an approved non-shrink grout prior to testing. Install drop-connections and gas sealing connections prior to testing.

1. Hydrostatic Test - Make manhole watertight and re-test if the manhole fails the leakage test. The maximum leakage for hydrostatic testing is 0.025 gallons per foot diameter per foot of manhole depth per hour. Prepare for hydrostatic exfiltration testing by sealing all wastewater lines coming into the manhole with an internal pipe plug, then fill the manhole with water and maintain full for at least one hour. With concrete manholes a period of 24 hours prior to testing may be used in order to allow saturation of the concrete.

2. Vacuum Test – Temporarily plug lines entering the manhole with the plugs braced to prevent them from being drawn into the manhole. Install plugs in the lines beyond drop-connections, gas sealing connections, etc. Place the test head inside the frame at the top of the manhole and inflate in accordance with the manufacturer's recommendations. Draw a vacuum of 10 inches of mercury, then turn off the vacuum pump. Read the level of vacuum after the required test time with the valve closed. The manhole will pass the test if the drop in the level is less than 1 inch of mercury (final vacuum greater than 9 inches of mercury). The required test time for 48", 60", and 72" manholes with depths up to 30 feet is one minute-thirty seconds. Test times for manholes of greater size and depths will be determined by the Engineer.
3. Manhole Repairs – Manholes will be accepted in accordance with the criteria above. Repair any manhole which fails the initial test with non-shrink grout or other suitable material as determine for the material from which the manhole is constructed. Retest the manhole as described above until a successful test is achieved. Remove all temporary plugs and grout after a successful test.

H. TESTS FOR PLUMBING DRAINAGE AND VENT SYSTEMS

1. Plug openings as necessary.
2. Test drainage and venting systems by filling piping with water to the level of the highest vent stack for 30 minutes.
3. Make the examination for leakage at joints and connections.
4. Test fail if there is any drop in water level.

3.6. ELECTRICAL TESTING

A. QUALIFICATIONS

1. Perform testing using qualified personnel with a minimum of five (5) years' experience installing and testing electrical equipment and machinery, unless otherwise specified.
2. Use testing firms or individuals to perform tests that have not provided services or materials used on the Project or are otherwise related or affiliated with other Contractors or Suppliers for this project unless permitted by the Owner.

B. REPORT FORMS

Complete appropriate test report neatly and in ink for the items being tested. Note listed data that is not applicable or cannot be obtained as "N/A" or document with an explanation for the omission. Incomplete test forms will not be witnessed by the Owner's Designated Representative. Repeat tests not accepted. Substitute forms recording similar data and test equipment as that specified may be used if approved by the Engineer.

C. TEST EQUIPMENT

1. Provide test equipment and materials necessary to perform the requested tests.
2. Test equipment and apparatus shall be appropriate for the full range and duration of the test to be performed.

3. Demonstrate that the test equipment is functioning properly, prior to the commencement of the test. Suspend the test and repair or replace the equipment if test equipment fails during any portion of a test. Repeat the test in its entirety or as otherwise required by the Owner's Designated Representative.
4. Provide a copy of the test equipment calibration certificate to the Owner's Designated Representative prior to the commencement of the test. Provide test equipment that has been calibrated with six (6) months of the date of the test using methods approved by the National Institute of Standards and Technology.

D. EXECUTION

1. Make appropriate repairs or replacements if the circuit, equipment or machinery being tested does not pass. Repeat test as directed by the Owner's Designated Representative.

The more rigid requirement prevail if test procedures or equipment conflicts occur between the various sections and/or Supplier's recommendations.

E. ELECTRICAL CABLE

1. COMMUNICATION CABLE AND CONDUCTORS - Submit test forms to the Owner's for approval prior to performing the following tests:
 - a. Test shielded pair, telephone, paging, signaling and computer cables for continuity, short circuits and grounds with a low voltage source, not to exceed the insulation rating of the conductors or jacket.
 - b. Test fiber-optic cable between terminating ends for each circuit per the Supplier's recommendation. Cables, splices (where permitted), and connectors shall be tested for continuity, band width (maximum), and attenuation losses.
2. 600 VOLT CABLE AND CONDUCTORS:
 - a. Test power and control conductors rated at 600 volts with an insulation resistance tester at 1,000 volts, with respect to ground, and at 1,000 volts with respect to all other conductors in each circuit.
 - b. Verify suitable ground connections are provided and maintained throughout the test.
 - c. Perform tests and record results as required by the "600 Volt Cable Test Report" or form provided by the Engineer.
 - d. Test each circuit and record the results for continuity between terminating ends with a low voltage source.
3. 5KV CABLE AND CONDUCTORS:
 - a. Perform insulation resistance test on 5KV cable for insulation resistance tested at 2,500 volts with respect to ground and at 2,500 volts with respect to all other conductors in each circuit.

- b. H-Pot test 5KV cables incrementally to 25 KVDC for 15 minutes per ANSI/IEE STD 400. Record leakage current in the spaces provided, at the time intervals shown, on the "Medium Voltage Cable Test Report." Do not exceed the cable Supplier's maximum test values or procedures.
 - c. Perform Individual conductor resistance tests and recorded results. Test each circuit for continuity between terminations ends and record the test results. Provide additional tests and checks as requested by the Supplier.
 - 4. 15KV CABLE AND CONDUCTORS:
 - a. Perform insulation resistance test on 15KV cable at 2500 volts with respect to all other conductors in each circuit.
 - b. H-Pot test 15KV cable incrementally to 55KVDC for 15 minutes per ANSI/IEE STD. 400. Record leakage current at the time interval, shown, on the "Medium Voltage Cable Test Report." Do not exceed the cable Supplier's recommended maximum test values or procedures. Perform individual conductor resistance tests and record the results. Test each circuit for continuity between terminating ends and record the results. Provide additional tests and checks as required by the Supplier.
- F. SWITCHGEAR
 - 1. Test electrical switchgear and electrical devices and controls mounted on or in the switchgear in accordance with the "Switchgear Test Report" form.
 - 2. Record the following information and attach to the test report:
 - a. Resistance reading across joints of each horizontal and vertical bus.
 - b. Verify proper operation of electrical, mechanical and keyed interlocking systems.
 - c. Operate devices to both their open and close states. Operate stored energy devices mechanically and electrically as applicable. Operate remotely controlled devices from their remote location.
 - d. Verify proper operation of draw-out circuit breakers and switches. Remove and re-install each unit. Verify proper operation of shutters and barriers.
 - e. Disconnect electrical and electronic sensing and protective devices not rated to withstand insulation resistance test potentials. Reconnect the devices before energizing the switchgear.
 - f. Perform insulation resistance tests at the test voltages shown below for the following equipment. Do not exceed the Supplier's recommended maximum test values or procedures.

Equipment Rating	Test Voltage
0-250 VOLTS	500 VOLTS
251-600 VOLTS	1,000 VOLTS
601-5,000 VOLTS	2,500 VOLTS
5,001-15,000 VOLTS	2,500 VOLTS
15,001-39,000 VOLTS	5,000 VOLTS

- g. Provide additional tests and checks as recommended by the Supplier before energizing.
- h. Energize switchgear. Measure and record instrument indications for no load and connected load conditions.

G. TRANSFORMERS

1. Test single and 3-phase, liquid filled and dry transformers rated 5KVA and larger in accordance with the "Transformer Test Report," form.
2. Record the following information and attach to the test report.
 - a. Verify proper operation of all fans, alarms, and other auxiliary and monitoring devices.
 - b. Verify "tap changer" operation, if applicable, in all positions. Set and secure "tap changer" to position recommended by the Owner's Designated Representative or Engineer.
 - c. Obtain insulating liquid sample from all liquid filled transformers. Submit sample to testing laboratory, approved by the Owner for analysis. Perform standard insulating liquid tests as required by the Owner's Designated Representative or Engineer. Deliver test results to the Owner within 30 days after sampling.
 - d. Perform insulation resistance tests at the test values shown below for the following equipment.
 - e. Perform tests from each winding to ground and winding to winding. Primary and secondary sections shall be tested separately.
 - f. Do not exceed the Supplier's recommended maximum test values or procedures.

Transformer Coil Rating	Test Voltage
0-600 VOLTS	1,000 VOLTS
601-5,000 VOLTS	2,500VOLTS
5,001-15,000VOLTS	5,000 VOLTS
15,001-39,000 VOLTS	10,000 VOLTS

- g. Provide additional tests and checks as recommended by the Supplier before energizing.
- h. Energize transformer. Measure and record primary and secondary volts and amps under no load and connected load conditions.

H. MOTORS

1. Test electric motors in accordance with the "Motor Start-Up Report" form.
2. Check and record motor winding continuity phase to phase with a low voltage source.
3. Check and record motor winding insulation resistance, each phase with respect to ground, at the test values shown below for A.C. induction motors per REF. IEEE Standard 43.

4. Do not exceed the Supplier's recommended maximum test values or procedures.

Motor Voltage Rating (Volts)	Test Voltage
250V and below	500
above 250 V	1,000
2,360 Volt - 3 Phase	Per Manufacturer's start-up instructions or as otherwise directed by the Engineer.

5. Check and record motor circuit voltage before starting motor.
6. Verify operation of motor space heater if applicable.
7. Provide additional tests and checks as recommended by the Supplier before energizing.
8. Start motor and verify immediately correct shaft rotation.
9. Check and record motor running volts and amps.
10. Verify correct operation of all interlocking and protective devices.

END OF SECTION

SECTION 014200 – REFERENCES

PART 1 – GENERAL

1.1. SUMMARY

A. Section Includes

1. This section specifies procedural and administrative requirements for compliance with governing regulations, codes, and standards imposed upon the Work. These requirements include obtaining permits, licenses, inspections, releases, and similar documentation, as well as payments, statements and similar requirements associated with regulations, codes, and standards.
 - a. The term "Regulations" is defined to include laws, statutes, ordinances, and lawful orders issued by governing authorities, as well as those rules, conventions and agreements within the construction industry which effectively control the performance of the work regardless of whether they are lawfully imposed by governing authority or not.
2. Governing Regulations: Refer to General and Special Conditions for requirements related to compliance with governing regulations.

1.2. DEFINITIONS

- A. General Explanation: Certain terms used in the contract documents are defined in this article. Definitions and explanations contained in this section are not necessarily complete but are general for the Work to the extent that they are not stated more explicitly in another element of the contract documents.
- B. General Requirements: Provisions and requirements of other Division - 01 sections apply to the entire work of the Contract and, where so indicated, to other elements which are included in the project.
- C. Indicated: The term "indicated" is a cross-reference to graphic representations notes or schedules on the drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for the purpose of helping the reader locate the cross-reference, and no limitation of location is intended except as specifically noted.
- D. Directed, Requested, etc.: Terms such as "directed", "requested", "authorized", "selected", "approved", "required", "accepted", and "permitted" mean "directed by the ENGINEER", "requested by the ENGINEER", and similar phrases. However, no such implied meaning will be interpreted to extend the ENGINEER's responsibility into the CONTRACTOR's area of construction supervision.

- E. Approve: Where used in conjunction with the ENGINEER's response to submittals, requests, applications, inquiries, reports and claims by the CONTRACTOR, the term "approved" will be held to limitations of the ENGINEER's responsibilities and duties as specified in General and Special Conditions. In no case will the ENGINEER's approval be interpreted as a release of the CONTRACTOR from responsibilities to fulfill requirements of contract documents or acceptance of the Work, unless otherwise provided by requirements of the contract documents.
- F. Project Site: The term "project site" means the space available to the CONTRACTOR for performance of the Work, either exclusively or in conjunction with others performing other construction as part of the project. The extent of the project site is shown on the drawings and may or may not be identical with the description of the land upon which the project is to be built.
- G. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations".
- H. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations".
- I. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use".
- J. Installer: The "installer" is "the entity" (person or firm) engaged by the CONTRACTOR, its subcontractor or sub-subcontractor for performance of a particular element of construction at the project site, including installation, erection, application, and similar required operations. It is a requirement that installers are experienced in the operations they are engaged to perform.
- K. Testing Laboratories: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests of the Work, either at the project site or elsewhere, and to report, and (if required) interpret results of those inspections or tests.

1.3. DRAWING SYMBOLS

- A. General: Except as otherwise indicated, graphic symbols used on the drawings are those symbols recognized in the construction industry for purposes indicated. Where not otherwise noted, symbols are defined by "Architectural Graphic Standards", published by John Wiley & Sons, Inc., seventh edition.
- B. Mechanical/Electrical Drawings: Graphic symbols used on mechanical and electrical drawings are generally aligned with symbols recommended by ASHRAE. Where appropriate, these symbols are supplemented by more specific symbols as recommended by other technical associations including ASME, ASPE, IEEE and similar organizations. Refer instances of uncertainty to the ENGINEER for clarification before proceeding.

1.4. INDUSTRY STANDARDS

- A. Applicability of Standards: Except where more explicit or stringent requirements are written into the contract documents, applicable construction industry standards have the same force and effect as if bound into or copied directly into the contract documents. Such industry standards are made a part of the contract documents by reference. Individual specification sections indicate which codes and standards the CONTRACTOR must keep available at the project site for reference.

1. Referenced standards (standards referenced directly in the contract documents) take precedence over standards that are not referenced but generally recognized in the industry for applicability to the Work.
 2. Unreferenced standards are not directly applicable to the Work, except as a general requirement of whether the Work complies with recognized construction industry standards.
- B. Publication Dates: Except as otherwise indicated, where compliance with an industry standard is required, comply with standard in effect as of date of contract documents.
- C. Conflicting Requirements: Where compliance with two or more standards is specified, and where these standards establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced unless the contract documents specifically indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the ENGINEER for a decision before proceeding.
- D. Copies of Standards: The contract documents require that each entity performing work be experienced in that part of the Work being performed. Each entity is also required to be familiar with industry standards applicable to that part of the Work. Copies of applicable standards are not bound with the contract documents.

Where copies of standards are needed for proper performance of the Work, the CONTRACTOR is required to obtain such copies directly from the publication source.

Although copies of standards needed for enforcement of requirements may be required submittals, the ENGINEER reserves the right to require the CONTRACTOR to submit additional copies as necessary for enforcement of requirements.

- E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where acronyms or abbreviations are used in the specifications or other contract documents they are defined to mean the recognized name of the trade association, standards generating organization, governing authority, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations", published by Gale Research Co., available in most libraries.

1.5. SUBMITTALS

- A. Permits, Licenses, and Certificates: For the OWNER's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

END OF SECTION

SECTION 014333 – MANUFACTURER'S SERVICES

PART 1 – GENERAL

1.1. SUMMARY

- A. This Section includes the requirements for the qualifications, services, training, installation assistance, certification, equipment commissioning, and related Work required for manufacturers' services.
- B. Related Sections include the following:
 - 1. Division 1 Section "Operation and Maintenance Data" for requirements for furnishing operation and maintenance information and materials.
 - 2. Division 1 Section "Equipment Testing and Facility Start-Up" for the testing of equipment and facility commissioning.
 - 3. Division 1 Section "Demonstration and Training" for information pertaining training and demonstration.
 - 4. Division 2 through 46 Sections for additional requirements.

1.2. DEFINITIONS

- A. Person-Day: One person for 8 hours within regular CONTRACTOR working hours.

1.3. SUBMITTALS

- A. Training Schedule: Submit not less than 21 days prior to start of equipment installation.
- B. Lesson Plan: Submit proposed lesson plan not less than 21 days prior to schedule training session.
- C. Training Session Tapes: Furnish OWNER with two complete sets of training tapes; indexed and cataloged with printed label stating session and date taped.

1.4. QUALITY ASSURANCE

- A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications require of equipment manufacturer. Additional qualifications may be specified in the individual Sections.
- B. Representative will be subject to acceptance by ENGINEER and OWNER. No substitute representative will be allowed unless prior written approval has been given.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1. MANUFACTURERS' SERVICES

- A. Furnish minimum manufacturers' services, when required by a Division 2 through 17 Section, to comply with the requirements of this Section.

- B. Where time is necessary in excess of that stated in the Section for manufacturers' services, or when a minimum time is not specified, the time required to perform the specified services shall be considered incidental.
- C. Schedule manufacturers' services to avoid conflict with other onsite testing or other manufacturers' onsite services.
- D. Determine, before scheduling manufacturers' services that all conditions necessary to allow successful completion of the services have been complied with.
- E. Only those days of service approved by ENGINEER will be credited to fulfill the specified minimum service.
- F. When specified by a Division 2 through 46 Section, manufacturer's onsite services shall include:
 - 1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, and instruction of CONTRACTOR'S personnel during the assembly, erection, installation or application Work.
 - 2. Inspection, checking, and adjustments as required for product (system, subsystem, or component) to function as warranted by manufacturer and required to provide Manufacturer's Certificate of Installation.
 - 3. Provide on a daily basis copies of manufacturer's representative field notes and data to ENGINEER.
 - 4. Visiting site as required to correct problems and until installation and operation are acceptable to ENGINEER.
 - 5. Resolution of assemble or installation problems attributable to, or associated with, respective manufacturer's products and systems.
 - 6. Assistance during functional and performance testing, facility start-up, evaluation, and commissioning.
 - 7. Training of OWNER'S personnel in the operation and maintenance of the product as required.
 - 8. Additional requirements may be specified in a Division 2 through 46.
 - 9. Include the cost of the services of the Manufacturer's representative in the equipment price which is included in the Contract Price

3.2. MANUFACTURER'S CERTIFICATE OF COMPLIANCE

- A. When specified in a Division 2 through 17 Section, provide a Manufacturer's Certificate of Compliance, shall be completed and signed by the entity supplying the product, material, or service prior to shipment. A copy of this form is attached to this Section.
- B. ENGINEER may permit use of certain products, materials, or service prior to sampling and testing if accompanied by an accepted Certificate of Compliance.
- C. The Certificate shall certify the product, material, or service complies with the Contract Documents. Attach supporting documentation as appropriate. This information may reflect previous test results on the product, material, or services.

3.3. MANUFACTURER'S CERTIFICATE OF INSTALLATION

- A. When specified in a Division 2 through 17 Section, provide a Manufacturer's Certificate of Installation, shall be completed and signed by the manufacturer's representative. A copy of this form is attached to this Section.
- B. The Certificate shall certify the signing party is a duly-authorized representative of the manufacturer, is empowered by the manufacturer to inspect, approve the installation, operate their equipment, and make recommendations required to ensure the equipment installation is complete and operational.

3.4. TRAINING

- A. Provide manufacturer's representative for detailed classroom and hands-on training to OWNER'S personnel on the operation and maintenance of specified product (system, subsystem, and component). Refer to Division 1 Section "Demonstration and Training" for addition requirements.
- B. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with OWNER and familiar with required operation and maintenance information specified in Division 1 Section "Operation and Maintenance Data."
- C. Furnish training materials, which will be retained by the trainee.

3.5. SUPPLEMENTS

- A. The following forms located after "END OF SECTION" are part of this Section.
 - 1. Form: Manufacturer's Certificate of Compliance.
 - 2. Form: Manufacturer's Certificate of Installation.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER:

PROJECT:

PRODUCT, MATERIAL OR SERVICE: _

Evaluation Comments:

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project has been furnished in accordance with all applicable requirements. I further certify that the product, material, or service is of the quality specified and conform in all respects with the Contract Documents, and of the quantity shown.

Date of Execution:

Manufacturer:

Manufacturer's Authorized Agent (Print):

(Authorized Signature)

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER:

PROJECT:

Tag No.

Serial no.

Project No.

Spec Section:

I hereby certify the above referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper lubricants.
- ☐ Electrical and mechanical connections meet quality and safety requirements.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functional test completed.
- ☐ System has been performance tested and meets or exceeds specified performance requirements. (When complete system furnished by single manufacturer)

Date of Execution:

Manufacturer:

Manufacturer's Authorized Agent (Print):

(Authorized Signature)

SECTION 015000 – TEMPORARY FACILITIES AND CONTROLS

PART 1 – GENERAL

1.1. SUMMARY

- A. Work Included: Provide temporary facilities and controls needed for the Work including, but not necessarily limited to:
 - 1. Temporary utilities such as water, electricity, and telephone;
 - 2. Field office shall not be required;
 - 3. Sanitary facilities;
 - 4. Enclosures such as tarpaulins, barricades, and canopies;
 - 5. Temporary fencing of the construction site;
 - 6. Security;
 - 7. Water, erosion, sediment, and dust control;
 - 8. Removal.
- B. Related Work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Provisions, Special Conditions, and Division 1 Specifications.
 - 2. Except that equipment furnished by subcontractors shall comply with requirements of pertinent safety regulations, such equipment normally furnished by the individual trades in execution of their own portions of the Work are not part of this Section.
 - 3. Permanent installation and hookup of the various utility lines are described in other Sections.
- C. Related Specification Sections include, but are not necessarily limited to:
 - a. General Provisions in Section D
 - (i) GP 3.13.1 – Site Constraints

1.2. REFERENCES [NOT USED]

1.3. ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4. SUBMITTALS [NOT USED]

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6. CLOSEOUT SUBMITTALS [NOT USED]

1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8. QUALITY ASSURANCE [NOT USED]

1.9. DELIVERY, STORAGE, AND HANDLING

- A. Maintain temporary facilities and controls in proper and safe condition throughout progress of the Work.

1.10. FIELD CONDITIONS [NOT USED]

1.11. WARRANTY [NOT USED]

PART 2 – PRODUCTS

2.1. UTILITIES

A. Water:

- 1. Water for construction shall be in accordance with Special Condition No. 12.
- 2. Irrigation water for establishing landscaping shall be at the CONTRACTOR's cost.

B. Electricity:

- 1. Provide necessary temporary wiring and, upon completion of the Work, remove such temporary facility.
- 2. Install all wiring in accordance with applicable electrical codes and safety requirements.
- 3. Furnish, install, operate, and maintain temporary lights as are required by law or ordinance, or by good safety practices, and as are necessary for the proper protection of the public and workmen, OWNER's employees, OWNER's guests and invitees, or as necessary for proper performance and inspection of the Work.
- 4. Provide and pay for electricity used in construction.
 - a. CONTRACTOR shall be responsible for setting a temporary meter to handle their electric requirements.
 - b. CONTRACTOR shall be responsible for electricity associated with starting of the pumps as well as pump operation between substantial and final completion.

C. Telephone:

- 1. Provide telephone, radio, and communication equipment for the CONTRACTOR's, OWNER's, and ENGINEER's use during construction.

2.2. TEMPORARY SANITARY FACILITIES

- A. Provide and maintain sanitary facilities for CONTRACTOR's employees, including those of all subcontractors, in the quantity required to meet site requirements and in accordance with local laws and codes.
 - 1. Number of portable toilets provided shall be in accordance with Section 1910.141 of the Occupational Safety & Health Administration (OSHA) Standards.
 - 2. See GC 3.26.1
- B. Transport sanitary sludge off-site for disposal in accordance with applicable local, state, and federal requirements.

2.3. FIELD OFFICES AND SHEDS

- A. Field Office shall be furnished for this project in accordance with the following: A Field Office shall not be required for this project.

2.4. DEWATERING

- A. For the entire duration of the Contract, the CONTRACTOR, at his expense, shall keep all parts of the project site, including excavations, free from any accumulation of water, regardless of the source or cause of such water, by adequate trenching and pumping as required.
- B. Pumping shall include adequate pumps, hose strainers, and other appurtenances, fuel, power, trenching, erosion control facilities, and pumping as required.
- C. Water shall be disposed of in such a manner as will not endanger public health or cause damage or expense to public or private property, and in accordance with the requirements of any public agencies having jurisdiction. If sewers and streets are used for drainage or the disposal of water during construction, they shall be maintained and left satisfactorily clean upon the completion of the work.

2.5. ENCLOSURES

- A. Provide and maintain for the duration of construction all scaffolds, tarpaulins, canopies, warning signs, steps, platforms, bridges, and other temporary construction necessary for proper completion of the Work in compliance with pertinent safety and other regulations.

2.6. TEMPORARY PROTECTION

- A. The CONTRACTOR or subcontractors shall also be responsible for protecting his work from damage due to the weather.

2.7. TEMPORARY FENCING

- A. Provide and maintain for the duration of construction a temporary fence of design and type needed to prevent entry onto the Work by the public.

PART 3 – EXECUTION

3.1. MAINTENANCE AND REMOVAL

- A. Maintain temporary facilities and controls as long as needed for safe and proper completion of the Work.
- B. Remove such temporary facilities and controls as rapidly as progress of the Work will permit, or as directed by the ENGINEER.

3.2. PROTECTION

- A. Provide spare safety helmets use by OWNER, ENGINEER, their representatives, and authorized visitors to the site.

END OF SECTION

SECTION 015723 – TEMPORARY STORM WATER POLLUTION CONTROL

PART 1 – GENERAL

1.1. SUMMARY

A. Contractor's Obligations

1. CONTRACTOR shall comply with all conditions of the State Water Resources Control Board ("State Water Board") National Pollutant Discharge Elimination System General Permit for Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction Activity ("Permit").
2. CONTRACTOR shall be responsible for filing the Notice of Intent and for obtaining the Permit. CONTRACTOR shall be solely responsible for preparing and implementing a Storm Water Pollution Prevention Plan ("SWPPP") prior to initiating Work. In bidding on this Project, CONTRACTOR's shall evaluate and include in his bid the cost of procuring the Permit and preparing the SWPPP as well as complying with the SWPPP and any necessary revision to the SWPPP.
3. CONTRACTOR shall comply with all requirements of the State Water Board.
4. CONTRACTOR shall include all costs of compliance with specified requirements in the Contract.
5. CONTRACTOR shall be responsible for procuring, implementing, and complying with the provisions of the Permit and the SWPPP, including the standard provisions, monitoring, and reporting requirements as required by the Permit. CONTRACTOR shall provide copies of all reports and monitoring information to the District.

B. Section Includes

1. Procedures for Storm Water Pollution Prevention Plans

C. Related Specification Sections include, but are not necessarily limited to

a. General Provisions in Section D

- (i) GP 3.15.3 – Water Pollution Control
- (ii) California State Water Resources Control Board, including the statewide General Permit for Discharges of Storm Waters Associated with Construction Sites

2. Division 1 – General Requirements

1.2. REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. State Water Resources Control Board's (SWRCB) National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities Order No. 2009-0009-DWQ (as amended by Orders 2010-0014-DWQ and 2012-0006-DWQ), NPDES No. CAS000002
3. California Stormwater Quality Association (CASQA) Construction Site Best Management Practices Manual, updated 2015.

1.3. ADMINISTRATIVE REQUIREMENTS

A. General

1. CONTRACTOR is responsible for resolution and payment of any fines issued associated with compliance to Storm Water Pollution Prevention Plan.

1.4. SUBMITTALS

- ##### A. Submittals shall be in accordance with Section 013323.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. SWPPP

1. Prior to the Preconstruction Meeting, submit a draft copy of SWPPP as follows:
 - (i) 1 copy to the OWNER
 - (ii) 1 copy to ENGINEER

B. Modified SWPPP

1. If the SWPPP is revised during construction, resubmit modified SWPPP to the ENGINEER and the OWNER in accordance with Section 013323.

1.6. CLOSEOUT SUBMITTALS [NOT USED]

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION [NOT USED]

END OF SECTION

SECTION 017123 – FIELD ENGINEERING

PART 1 – GENERAL

1.1. SUMMARY

- A. Work included: Provide such field engineering services, which is defined as engineering services to be provided by the CONTRACTOR to complete the construction according to the plans and specifications, as are required for proper completion of the Work including, but not necessarily limited to:
 - 1. Establishing and maintaining control, lines, and levels.
 - 2. Structural design of shores, forms, and similar items provided by the CONTRACTOR as part of his means and methods of construction.
- B. Related Specification Sections include, but are not necessarily limited to:
 - a. General Provisions in Section D
 - (i) GP 2.3.3 – Surveys

1.2. REFERENCES [NOT USED]

1.3. ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4. SUBMITTALS

- A. Comply with pertinent provisions of Section 013323 “Shop Drawings, Product Data, and Samples”.
- B. Upon request of the ENGINEER, submit:
 - 1. Data demonstrating qualifications of persons proposed to be engaged for field engineering services.
 - 2. Documentation verifying accuracy of field engineering work.
 - 3. Certification, signed by the CONTRACTOR's retained field engineer, certifying that elevations and locations of improvements are in conformance or non-conformance with requirements of the Contract Documents.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6. CLOSEOUT SUBMITTALS [NOT USED]

1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8. 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 procedures directed by the CONTRACTOR for proper performance of the CONTRACTOR's responsibilities:
 - 1. Locate and protect control points before starting work on the site.

2. Preserve permanent reference points during progress of the Work.
3. Do not change or relocate reference points or items of the Work without specific approval from the ENGINEER.
4. Promptly advise the ENGINEER when a reference point is lost or destroyed or requires relocation because of other changes in the Work.
 - a. Upon direction of the ENGINEER, require the field engineer to replace reference stakes or markers.
 - b. Locate such replacements according to the original survey control.

1.9. DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10. FIELD CONDITIONS [NOT USED]

1.11. WARRANTY [NOT USED]

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION [NOT USED]

END OF SECTION

SECTION 017500 – STARTING AND ADJUSTING

PART 1 – GENERAL

1.1. SUMMARY

- A. Provide step-by-step procedures for starting provided systems, including equipment, pumps and processes.
- B. Provide pre-startup inspections by equipment manufacturers
- C. Provide instruction and demonstration of operation, adjustment, and maintenance of each system and the component parts
- D. Place each system in service and operate the system to prove performance and to provide for initial correction of defects in workmanship, calibration, and operation.
- E. Provide for initial maintenance and operation

1.2. SUBMITTALS

- A. Provide a plan of action for testing, checking, and starting major equipment and process piping systems.
- B. Provide Operation and Maintenance Manuals per Section 01 78 23, OPERATION AND MAINTENANCE DATA

PART 2 – PRODUCTS

2.1. TESTING INSTRUMENTATION

- A. Furnish any instrumentation or other testing devices needed to conduct tests.

PART 3 – EXECUTION

3.1. SERVICES OF SUPPLIER'S REPRESENTATIVES

- A. Provide the services of a Supplier's representative for inspection, supervision of installation, and training. Supervisor's representative must be an experienced and competent technical (not sales) representative of the Supplier.
- B. Perform installation, adjustment, and testing of the equipment under the direct supervision of the Supplier's representative where specified.
- C. Provide the services of the Supplier's representative to instruct the Owner or his authorized personnel on operational procedures and maintenance requirements.
- D. Include the cost of the services of the Supplier's representative in the equipment price which is included in the Contract Price

3.2. INSPECTION AND STARTUP

- A. Inspect equipment prior to placing any equipment or system into operation. Make adjustments as necessary for proper operation.
 - 1. Check for adequate and proper lubrication.

2. Determine that parts or components are free from undue stress from structural members, piping or anchorage.
 3. Adjust equipment for proper balance and operations.
 4. Determine that vibrations are within acceptable limits.
 5. Determine that equipment operates properly under full load conditions.
 6. Determine that the equipment is in true alignment.
- B. Have the Supplier's representative present when the equipment is placed in operation.
1. The Supplier is to be on-Site as often as necessary for proper and trouble-free operation.
 2. Ensure that the proper procedure is employed in startup of systems.

3.3. INITIAL OPERATION

- A. Start, test, and place equipment and systems into operation for 30 days to allow the Owner and Engineer to observe the operation and overall performance of the equipment and to determine that controls function as intended.
- B. Equipment which operates on a limited or part-time basis shall be operated in the presence of the Engineer to demonstrate that controls function as specified.
- C. Perform acceptance test as specified in individual sections of the Specifications. Demonstrate that equipment and systems meet the specified performance criteria
- D. Unless specifically stated otherwise in the individual equipment Specifications, equipment and systems are not Substantially Complete until the end of this initial operation period. If an exception to this requirement is specifically noted in an individual equipment Specification, the exception shall only apply to that particular piece of equipment and not to the remaining components provided under the Project.

3.4. OPERATOR TRAINING

- A. Provide instruction and demonstration of the care and operation of the equipment to the Owner's personnel. Instruction is to include classroom and hands-on training.
- B. Provide training in adequate detail to ensure that the trainees who complete the program will be qualified and capable of operating and maintaining the equipment, products, and systems provided.
- C. Operations training is to include but not be limited to:
 1. Orientation to provide an overview of system/subsystem configuration and operation
 2. Terminology, nomenclature, and display symbols.
 3. Operations theory.
 4. Equipment appearance, functions, concepts, and operation.
 5. Operating modes, practices and procedures under normal, diminished, and emergency conditions.
 6. Startup and shutdown procedures.
 7. Safety precautions

8. On-the-job operating experience for monitoring functions, supervisory, or command activities. Include functions and activities associated with diminished operating modes, failure recognition, and responses to system/subsystem and recovery procedures.
9. Content and use of Operation and Maintenance manuals and related reference materials.
- D. Provide training for performing on-Site routine, preventive, and remedial maintenance of the equipment, product, or system. Maintenance training is to include but not be limited to:
 1. Orientation to provide an overview of system/subsystem concept, configuration, and operation.
 2. Operations theory and interfaces.
 3. Instructions necessary to ensure a basic theoretical and practical understanding of equipment appearance, layout and functions.
 4. Safety precautions.
 5. Use of standard and special tools and test equipment.
 6. Adjustment, calibration, and use of related test equipment.
 7. Detailed preventive maintenance activities.
 8. Troubleshooting, diagnostics, and testing.
 9. Equipment assembly and disassembly.
 10. Repair and parts replacement.
 11. Parts ordering practices and storage.
 12. Failure and recovery procedures.
 13. Cabling and/or interface connectors.
 14. Content and use of Operation and Maintenance Manuals and related reference materials.
 15. Procedures for warranty repairs.
 16. Lubrication.
 17. Procedures, practices, documentation, and materials required to commence system maintenance.
- E. Provide a training plan that indicates the schedule and sequence of the training programs. The training plan is to include for each course:
 1. Number of hours for the course.
 2. Agenda and narrative description, including the defined objectives for each lesson.
 3. Draft copy of training handbooks.
 4. A descriptive listing of suggested reference publications.
 5. Audio-visual equipment required for training.
 6. Type and number of tools or test equipment required for each training session.
- F. Provide qualified instructors to conduct the training.

- G. Training may be recorded by the Owner or its consultants for use in future training. Provide legal releases or pay additional fees required to allow training by the Supplier to be recorded.
- H. Schedule for training is to be approved by Owner.
 - 1. Schedule training and startup operations for no more than one piece of equipment or system at a time.
 - 2. Owner may require re-scheduling of training if operations personnel are not available for training on a scheduled date.
 - 3. Provide a minimum of 2 weeks' notice if training must be rescheduled.
- I. Schedule and coordinate training for equipment, products, or systems which depend upon other equipment or systems for proper operation so that trainees can be made familiar with the operation and maintenance of the entire operating system.
- J. Conduct a training course including, but not limited to, equipment products and systems listed below. Training is to be adequate to meet the training objectives described above and is to be for at least the minimum time indicated.

3.5. INITIAL MAINTENANCE

- A. Maintain equipment until the Project is accepted by the Owner (Final Completion)
 - 1. Ensure that mechanical equipment is properly greased, oiled, or otherwise cared for as recommended by the supplier.
- B. Service equipment per the supplier's instructions immediately before releasing the equipment to the Owner.

END OF SECTION

UNIT PROCESS STARTUP FORM

OWNER:

PROJECT:

Unit Process Description: (Include description and equipment number of all equipment and devices)

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.):

Evaluation Comments:

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER:

PROJECT:

Unit Process Description: (Include description and equipment number of all equipment and devices)

Unit Process Startup Sequence (Describe sequential startup and evaluation, including computerized operations)

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: Date: _____, 20____

Engineer: Date: _____, 20____

(Authorized Signature)

Owner: Date: _____, 20____

(Authorized Signature)

SECTION 017700 – CLOSEOUT PROCEDURES

PART 1 – GENERAL

1.1. SUMMARY

- A. Work Included: Provide an orderly and efficient transfer of the completed Work to the OWNER.
- B. Related Specification Sections include but are not necessarily limited to
 - 1. General Provisions in Section D.
 - a. GP 4.2.7 – Substantial Completion and Project Closeout
 - 2. Division -01 - General Requirements.

1.2. REFERENCES [NOT USED]

1.3. ADMINISTRATIVE REQUIREMENTS

A. Procedures

1. Substantial Completion:

- a. The ENGINEER and the CONTRACTOR will prepare a list of items to be completed by the CONTRACTOR.
- b. Within a reasonable time after receipt of the list, the ENGINEER will inspect to determine status of completion.
- c. Should the ENGINEER determine that the Work is not substantially complete:
 - (i) The ENGINEER promptly will so notify the CONTRACTOR, in writing, giving the reasons therefore.
 - (ii) Remedy the deficiencies and notify the ENGINEER when ready for reinspection.
 - (iii) The ENGINEER will re-inspect the Work.
- d. When the ENGINEER concurs that the Work is substantially complete:
 - (i) The ENGINEER will prepare a Letter accompanied by the CONTRACTOR's list of items to be completed or corrected, as verified by the ENGINEER.
 - (ii) The ENGINEER will submit the Letter to the OWNER and to the CONTRACTOR for their written acceptance of the responsibilities assigned to them in the Letter.
 - (iii) CONTRACTOR shall have a maximum of four weeks to complete the assigned tasks on the final punch list.

2. Final Completion:

- a. Prepare and submit notice.
- b. Verify that the Work is complete.

- c. Certify that:
 - (i) Contract Documents have been reviewed;
 - (ii) Work has been inspected for compliance with the Contract Documents;
 - (iii) Work has been completed in accordance with the Contract Documents;
 - (iv) Equipment and systems have been tested as required, and are operational;
 - (v) Work is completed and ready for final inspection.
- d. The ENGINEER will inspect to verify status of completion.
- e. Should the ENGINEER determine that the Work is incomplete or defective:
 - (i) The ENGINEER promptly will so notify the CONTRACTOR, in writing, listing the incomplete or defective work.
 - (ii) Remedy the deficiencies promptly and notify the ENGINEER when ready for re-inspection.
- f. When the ENGINEER determines that the Work is acceptable under the Contract Documents, he will request the CONTRACTOR to make close-out submittals.

1.4. SUBMITTALS

- A. Submittals shall be in accordance with Section 013323.
- B. All submittals shall be approved by the ENGINEER or the OWNER prior to delivery and/or fabrication for specials.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6. CLOSEOUT SUBMITTALS

- A. Close-out submittals include, but are not necessarily limited to:
 - 1. Project Record Documents described in Section 017839;
 - 2. Operation and maintenance data for items so listed in pertinent other Sections of these Specifications, and for other items when so directed by the ENGINEER;
 - 3. Warranties and bonds;
 - 4. Keys and keying schedule;
 - 5. Spare parts and materials extra stock;
 - 6. Evidence of compliance with requirements of governmental agencies having jurisdiction including, but not necessarily limited to:
 - a. Certificates of Inspection;
 - b. Certificates of Occupancy.
 - 7. Certificates of Insurance for products and completed operations;
 - 8. Evidence of payment and release of liens;

9. List of subcontractors, service organizations, and principal vendors, including names, addresses, and telephone numbers where they can be reached for emergency service at all times including nights, weekends, and holidays.
- B. Final adjustment of accounts:
 1. Submit a final statement of accounting to the ENGINEER, showing all adjustments to the Contract Sum.
 2. If so required, the OWNER will prepare a final Change Order showing adjustments to the Contract Sum which were not made previously by Change Orders.
- C. Instructions:
 1. Instruct the OWNER's personnel in proper operation and maintenance of systems, equipment, and similar items which were provided as part of the Work. CONTRACTOR shall be responsible for arranging for the instructions and supervision at a time convenient to the OWNER or his representatives. Instructions shall be provided on the following equipment:
 - a. Non-Clog Submersible Sewage Pumps
 - b. Electromagnetic Meter
 - c. Surge/Pressure Relief Valve
 - d. Submersible Mechanical Mixer
 - e. Process Control System Training
 - f. Arc Flash Training
 - g. Emergency Standby Generator Set
 - (i) Integrated Process Control System
 - (ii) PLC Hardware/Software
 - (iii) Field Instruments
 - (iv) Panel Instruments
 - (v) Operator (Pre-Startup)
 - (vi) Operator (Post-Startup)
 - h. Low Voltage Motor Control Centers
- 1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
- 1.8. QUALITY ASSURANCE
 - A. Prior to requesting inspection by the ENGINEER, use adequate means to assure that the Work is completed in accordance with the specified requirements and is ready for the requested inspection.
- 1.9. FIELD CONDITIONS [NOT USED]
- 1.10. WARRANTY [NOT USED]

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION [NOT USED]

END OF SECTION

SECTION 017823 – OPERATION AND MAINTENANCE DATA

PART 1 – GENERAL

1.1. SUMMARY

A. Work Included:

1. Throughout progress of the Work, assemble data for inclusion in an Operation and Maintenance Manual.
2. Upon completion of the Work, submit Operation and Maintenance Manuals to the ENGINEER, as described in Article 3.1 below.

B. Related Specification Sections include but are not necessarily limited to

1. General Provisions in Section D.
 - a. GP 9.7.4 – Conditions
 - (i) Number 5
2. Division 1 – General Requirements.

1.2. REFERENCES [NOT USED]

1.3. ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4. SUBMITTALS

- A. Submittals shall be in accordance with Section 013323.
- B. All submittals shall be approved by the ENGINEER or the OWNER prior to delivery and/or fabrication for specials.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

- A. Operation and Maintenance manuals shall be provided in electronic format on a compact disc. O&M manual shall be provided for the following pieces of equipment:
 1. Screw Press including all ancillary subsystems described in Section 467600
 2. Resilient Seated Gate Valves
 3. Air Release/Vacuum Valves
 4. Electromagnetic Flow Meter
 5. Swing Check Valve
 6. Chopper Pumps
 7. Process Control Systems
 8. NEMA Frame Induction Motors, 600 Volts and Below
 9. Power Metering and Protective Relays
 10. Low Voltage AC Surge Protective Devices (SPDs)
 11. Distribution Dry-Type Transformers

12. Panelboards

13. Low Voltage Enclosed Circuit Breakers and Disconnect Switches

1.6. CLOSEOUT SUBMITTALS [NOT USED]

1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8. QUALITY ASSURANCE [NOT USED]

1.9. FIELD CONDITIONS [NOT USED]

1.10. WARRANTY [NOT USED]

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION

3.1. OPERATION AND MAINTENANCE MANUALS

- A. Organize operating and maintenance data into suitable sets of manageable size.
- B. A separate PDF shall be included for each individual Operation and Maintenance (O&M) manual.
 - 1. All O&M manuals shall be provided on a single CD.
 - 2. Within individual PDF's, O&M sections shall be bookmarked to allow for easy reference.
- C. O&M's shall be project specific. At a minimum, the following types of information shall be included in O&M's manuals:
 - 1. Emergency instructions.
 - 2. Spare parts listing.
 - 3. Copies of warranties.
 - 4. Wiring diagrams (Project specific).
 - 5. Recommended "turn-around" cycles.
 - 6. Inspection procedures.
 - 7. Operating procedures
 - a. Start-up, break-in, routine, and normal operating instructions
 - b. Regulation, control, stopping, shut down and emergency instructions
 - c. Summer and winter operating instructions
 - d. Special operating instructions
 - 8. Maintenance procedures
 - a. Routine operations
 - b. Guide to "trouble shooting"
 - c. Disassembly, repair and reassembly
 - d. Alignment, adjusting and checking

9. Servicing and lubrication schedule
 - a. List of lubricants required
10. Shop drawings and product data (Project specific).

END OF SECTION

SECTION 017839 – PROJECT RECORD DOCUMENTS

PART 1 – GENERAL

1.1. SUMMARY

A. Work Included:

1. Throughout progress of the Work, maintain an accurate record of changes in the Contract Documents, as described in Paragraph 3.01 below.
2. Upon completion of the Work, transfer the recorded changes to a set of Record Documents, as described in Paragraph 3.02 below.

B. Related Specification Sections include but are not necessarily limited to

1. General Provisions in Section D.
 - a. GP 3.10.1 – As-Built and Record Documents
2. Division 1 – General Requirements.

1.2. REFERENCES [NOT USED]

1.3. ADMINISTRATIVE REQUIREMENTS

A. Product Handling

1. Maintain the job set of Record Documents completely protected from deterioration and from loss and damage until completion of the Work and transfer of all recorded data to the final Project Record Documents.
2. In the event of loss of recorded data, use means necessary to again secure the data to the ENGINEER's approval.
 - a. Such means shall include, if necessary in the opinion of the ENGINEER, removal and replacement of concealing materials.
 - b. In such case, provide replacements to the standards originally required by the Contract Documents.

B. Submittal Schedule

1. The ENGINEER's approval of the current status of Project Record Documents may be a prerequisite to the ENGINEER's approval of requests for progress payment and request for final payment under the Contract.
2. Prior to submitting each request for progress payment, secure the ENGINEER's approval of the current status of the Project Record Documents.
3. Prior to submitting request for final payment, submit the final Project Record Documents to the ENGINEER and secure his approval.

1.4. SUBMITTALS

- ##### A. Submittals shall be in accordance with Section 013323.

- B. All submittals shall be approved by the ENGINEER or the OWNER prior to delivery and/or fabrication for specials.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6. CLOSEOUT SUBMITTALS [NOT USED]

1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8. QUALITY ASSURANCE

- A. Delegate the responsibility for maintenance of Record Documents to one person on the CONTRACTOR's staff as approved by the ENGINEER.
- B. Accuracy of records:
 - 1. Thoroughly coordinate changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other Documents where such entry is required to show the change properly.
 - 2. Accuracy of records shall be such that future search for items shown in the Contract Documents may rely reasonably on information obtained from the approved Project Record Documents.
- C. Make entries within 24 hours after receipt of information that the change has occurred.

1.9. FIELD CONDITIONS [NOT USED]

1.10. WARRANTY [NOT USED]

PART 2 – PRODUCTS

2.1. RECORD DOCUMENTS

- A. Job set: Promptly following receipt of the OWNER's Notice to Proceed, secure from the ENGINEER at no charge to the CONTRACTOR one complete set of all Documents comprising the Contract.
- B. Final Record Documents: At a time nearing the completion of the Work, secure from the ENGINEER at no charge to the CONTRACTOR one complete bond set of all Drawings in the Contract.

PART 3 – EXECUTION

3.1. MAINTENANCE OF JOB SET

- A. Immediately upon receipt of the job set described in Paragraph 2.01.A above, identify each of the Documents with the title, "RECORD DOCUMENTS - JOB SET".
- B. Preservation:
 - 1. Considering the Contract completion time, the probable number of occasions upon which the job set must be taken out for new entries and for examination, and the conditions under which these activities will be performed, devise a suitable method for protecting the job set to the approval of the ENGINEER.

2. Do not use the job set for any purpose except entry of new data and for review by the ENGINEER, until start of transfer of data to Final Project Record Documents.
3. Maintain the job set at the site of Work as that site is designated by the ENGINEER.
- C. Making entries on Drawings:
 1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required.
 2. Date all entries.
 3. Call attention to the entry by a "cloud" drawn around the area or areas affected.
 4. In the event of overlapping changes, use different colors for the overlapping changes.
- D. Make entries in the pertinent other Documents as approved by the ENGINEER.
- E. Conversion of schematic layouts:
 1. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and is not intended to portray precise physical layout.
 - a. Final physical arrangement is determined by the CONTRACTOR, subject to the ENGINEER's approval.
 - b. However, design of future modifications of the facility may require accurate information as to the final physical layout of items which are shown only schematically on the Drawings.
 2. Show on the job set of Record Drawings, by dimension accurate to within one inch, the centerline of each run of items such as are described in subparagraph 3.01-E-1 above.
 - a. Final physical arrangement is determined by the CONTRACTOR, subject to the ENGINEER's approval.
 - b. Show, by symbol or note, the vertical location of the Item ("under slab", "in ceiling plenum", "exposed", and the like).
 - c. Make all identification sufficiently descriptive that it may be related reliably to the Specifications.
 3. The ENGINEER may waive the requirements for conversion of schematic layouts where, in the ENGINEER's judgment, conversion serves no useful purpose. However, do not rely upon waivers being issued except as specifically issued in writing by the ENGINEER.

3.2. FINAL PROJECT RECORD DOCUMENTS

- A. The purpose of the Final Project Record Documents is to provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive site measurement, investigation, and examination.
- B. Approval of recorded data prior to transfer:
 1. Following receipt of the drawings described in Paragraph 2.01-B above, and prior to start of transfer of recorded data thereto, secure the ENGINEER's approval of all recorded data.

2. Make required revisions.
 - C. Transfer of data to Drawings:
 1. Carefully transfer change data shown on the job set of Project Record Drawings to the corresponding drawings, coordinating the changes as required.
 2. Clearly indicate at each affected detail and other Drawings a full description of changes made during construction, and the actual location of items described in Paragraph 3.01 above.
 3. Call attention to each entry by drawing a "cloud" around the area or areas affected.
 4. Make changes neatly, consistently, and with the proper media to assure longevity and clear reproduction.
 - D. Transfer of data to other Documents:
 1. If the Documents other than Drawings have been kept clean during progress of the Work, and if entries thereon have been orderly to the approval of the ENGINEER, the job set of those Documents other than Drawings will be accepted as Final Project Record Documents.
 2. If any such Document is not so approved by the ENGINEER, secure a new copy of that Document from the ENGINEER at the ENGINEER's usual charge for reproduction and handling, and carefully transfer the change data to the new copy to the approval of the ENGINEER.
 - E. Review and submittal:
 1. Submit the completed set of Project Record Documents to the ENGINEER as described above.
 2. Participate in review meetings as required.
 3. Make required changes and promptly deliver the Final Project Record Documents to the ENGINEER.
- 3.3. CHANGES SUBSEQUENT TO ACCEPTANCE
- A. The CONTRACTOR has no responsibility for recording changes in the Work subsequent to Final Completion, except for changes resulting from work performed under Warranty.

END OF SECTION

SECTION 024100 – DEMOLITION

PART 1 – GENERAL

1.1. SCOPE OF WORK

- A. The CONTRACTOR shall furnish all supervised labor, materials, equipment, and incidentals required for the removal of existing structures, equipment, piping, and other improvements.
- B. The CONTRACTOR shall furnish all supervised labor, materials, equipment, and incidentals required for the removal of any pavement, including base material, as shown on the construction plans. Removal procedures are as outlined below:
 - 1. Complete or partial removal and disposal of specified existing piping, mechanical equipment, electrical equipment, and miscellaneous appurtenances encountered during construction operations.
 - 2. Temporary modification of structures, equipment, appurtenances, and utilities as necessary to allow for operation of the facilities during construction.
 - 3. Demolition, partial removal and cutting of existing concrete structure as required for the new construction.
 - 4. Handling of existing equipment to be reinstalled or salvageable as specified.
 - 5. Off-site disposal of excess and unacceptable materials including but not limited to concrete, concrete blocks, and bricks. All materials to be disposed of in a legal manner.
 - 6. This section may not cover all of the activities necessary to perform the work. The CONTRACTOR shall exercise due concern for the utility system operation and shall diligently direct all of the CONTRACTOR's activities toward maintaining continuous operation of the existing facilities and minimizing operation impacts.

1.2. CONDITION OF STRUCTURES

- A. The OWNER and the ENGINEER assume no responsibility for the actual condition of the concrete pedestals and pipe supports to be modified.
- B. By submitting a bid, the CONTRACTOR affirms that the CONTRACTOR has carefully examined the site and all conditions affecting the Work. Conditions existing at the time of inspection for bidding purposes will be maintained by the OWNER insofar as practicable.

1.3. RULES AND REGULATIONS

- A. The Building Code of the State of California and the County of San Bernardino shall control the demolition, modification, or alteration of the existing pedestals.
- B. No blasting shall be done on site.

1.4. SUBMITTALS

- A. Provide a detailed sequence of demolition and removal work as part of the CONTRACTOR's schedule.

1.5. ACCESS

- A. Conduct demolition and modification operations, and the removal of equipment and debris to ensure minimum interference with roads and walks both on-site and off-site and to ensure minimum interference with occupied or used facilities.
- B. Special attention is directed towards maintaining safe and convenient access to the existing facilities by OWNER's operations personnel and associated vehicles.
- C. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the ENGINEER. Provide alternate routes around closed or obstructed traffic in access ways.

1.6. PROTECTION

- A. The CONTRACTOR shall conduct construction activities to minimize damage to adjacent buildings, structures, utilities, storm drainage, and other facilities, including persons.

1.7. DAMAGE

- A. The CONTRACTOR shall immediately report damage caused to adjacent facilities by demolition operations. The CONTRACTOR shall promptly make all required repairs as directed by the ENGINEER and at no cost to the OWNER.

1.8. UTILITIES

- A. It shall be the CONTRACTOR's responsibility to maintain existing utilities in service and protect against damage during demolition operations.

1.9. POLLUTION CONTROL

- A. For pollution control, use sprinkling, temporary enclosures, and other suitable methods as necessary to limit the amount of dust and dirt rising and scattering in the air to the lowest level of air pollution practical for the conditions of work. Comply with the governing regulations.
- B. Clean adjacent structures and improvements of all dust, dirt, and debris caused by demolition operations. Return areas to conditions existing prior to the start of work.

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION

3.1. REMOVAL OF EXISTING EQUIPMENT, PIPING AND APPURTENANCES

- A. Subject to the constraints of maintaining the existing utilities in operation; existing pumping equipment, valves, piping, and appurtenances not necessary for the operation of the new facility shall remain the property of the OWNER unless otherwise directed by the OWNER. The CONTRACTOR shall remove, clean, and prepare for storage all equipment to remain as directed by the OWNER. If the OWNER elects not to retain ownership of a certain item, the item shall become the property of the CONTRACTOR and shall be removed from the site at the CONTRACTOR's expense.
- B. All equipment and materials to be stored for reinstallation or salvage shall be properly protected from damage.

- C. Any items of equipment damaged or lost due to the CONTRACTOR's carelessness, mishandling, or faulty procedures and/or workmanship shall be repaired or replaced in kind to the satisfaction of the ENGINEER.

END OF SECTION

SECTION 031000 – CONCRETE FORMING AND ACCESSORIES

PART 1 – GENERAL

1.1. DESCRIPTION

- A. Provide forms for cast-in-place concrete as shown on the drawings, as specified herein or as otherwise required.

1.2. COORDINATION

- A. Pipe sleeves, wall spools, wall flanges, anchors and bolts, inserts, supports and other required materials in connection with concrete construction, shall be secured in position before the concrete is placed. Do not weld, tie, or otherwise connect the wall spools or anchors to the reinforcing steel.
- B. Schedule and coordinate the installation of items to be embedded in concrete to avoid delaying the project.
- C. Cutting and patching made necessary by failure or delay in complying with these requirements shall be provided at no cost to the OWNER.
- D. Concrete formwork shall be designed and constructed to safely support the wet concrete without excessive deflection or concrete leakage. Bracing shall be provided to maintain accurate alignment and to resist anticipated lateral loads. Forms shall conform to the drawings as to shape, line, and dimension. The design and engineering of the forms, as well as the construction, shall be the responsibility of the CONTRACTOR. Concrete forms to be designed according to ACI 347 standards.
- E. All forms shall be designed in a manner so the stresses in the different members can be determined, including details. Forms shall have sufficient rigidity so as to limit deflections to 1/360 of the span or 1/16 inch, whichever is less, between supports after the concrete has been placed and to assure a smooth and even appearance of exposed surfaces.

PART 2 – MATERIALS

2.1. FORM LUMBER

- A. For exposed concrete A.P.A. graded plyform, grade B-B, Class 1 or 2, as required for strength and tolerance requirements per ACI standards.

2.2. FORM SEALER

- A. For exposed concrete use "Form Sealer" by Burke or approved equal.

2.3. ACCESSORIES

- A. Cold joints (slabs on grade) "Keyed Kold" by Burke or approved equal.

2.4. FORM TIES AND SPREADERS

- A. Shall be metal, cone nut type; no wood spreaders will be permitted.

2.5. ROUGH HARDWARE

- A. Provide nails, bolts, anchors, etc. as shown or required. Bolts, rods, and other approved devices shall be used for internal ties and spreaders. These shall be of such construction that when the forms are removed, no metal shall be within one (1) inch of an exterior nor within one-half (1/2) inch of an interior concrete surface or as shown on drawings.

2.6. FORM RELEASE AGENT

- A. Form release agent shall effectively prevent absorption of moisture and prevent bond with the concrete. Agent shall be nonstaining and nontoxic after 30 days.
- B. For steel forms, release agent shall prevent discoloration of the concrete due to rust.

PART 3 – EXECUTION

3.1. INSPECTION

- A. Formwork shall be inspected and approved by the ENGINEER before any concrete is placed. The ENGINEER shall be notified forty-eight (48) hours in advance of time the forms are complete for inspection.

3.2. CONSTRUCTION JOINTS

- A. Construction joints shall be located only as indicated on the drawings and in a manner not to impair the strength of the structure. Other locations only as approved by the ENGINEER. Form keys in cold joints.
- B. Concreting shall be carried out continuously up to construction joints, the arrangement, and positions of which shall be as shown on the drawings, or as approved by the ENGINEER. Whenever concreting is forced to cease, a new construction joint will be formed conforming to these specifications.
- C. Construction joints shall be approximately horizontal or vertical except in concrete tunnel lining. The joints shall appear as straight lines at exposed faces.
- D. The surface of construction joints upon or against which new concrete is to be placed shall be clean, rough (green cut), and damp but free of standing water when covered with fresh concrete. The laitance, loose, or defective, concrete, and foreign material shall be removed from the surface of existing concrete and shall result in a roughened surface with approximately 1/4-inch full amplitude. Undercutting of aggregate shall be avoided.
- E. Joint surfaces which have hardened shall be cleaned and roughened by wet sandblasting. Wet sandblasting equipment shall be operated at a pressure of approximately 100 psi. Sand to be used for blasting shall be dense, hard, not easily broken and sufficiently dry.
- F. In lieu of wet-sandblasting, the CONTRACTOR may propose high-pressure air-water blasting provided that such high-pressure air-water blasting will produce equivalent results to those obtainable by wet-sandblasting.
- G. The horizontal surfaces of construction joints may be treated by cutting with a water jet. This shall be performed after the initial set has taken place but before the concrete has become too hard for effective cutting. The fresh concrete surface shall be cut with water jets to remove all laitance and to expose clean, sound aggregate. After cutting, the surface shall be washed with clean water. Care shall be taken that the treated surface does not become contaminated before new concrete is placed upon it.

- H. Water used in cutting, washing, and rinsing of concrete surfaces shall be disposed of in such a way that it does not stain, discolor, or affect exposed surfaces of the structures.
- I. Instead of a starter mix, the ENGINEER may, in particular cases, require a layer of mortar approximately 1/2-inch thick. This mortar shall be of the same proportions as that in the concrete.

3.3. FORMS AND CURVED SURFACES

- A. Shall be built-up with band sawed two (2) inch nominal stringers, sized and carefully fitted to desired form, with segmental backing. Inside face to be oil tempered hardboard or 1/4" MOO plyform.
- B. Provide chamfer strips of 3/4" x 3/4" material at any wall, column and vertical corners, all vertical and horizontal edges, unless otherwise shown on the drawings.

3.4. PREPARATION

- A. Immediately before placing concrete, alignment and level of forms shall be checked and wedges shall be secured in place. Once the forms are in final position and all embeds and rebar are in place, the CONTRACTOR's representative will contact the ENGINEER for approval to pour. Concrete shall not be placed until all formwork, installation of embedded parts and structures against which concrete is to be cast have been accepted by the ENGINEER in writing or on an approved pour card.
- B. Should misalignment of forms or screeds, excessive deflection of forms or displacement of forms occur during concrete placement, corrective measures shall be made immediately. If directed by ENGINEER, placing operations shall be stopped and concrete shall be removed from within the forms.
- C. Loose soil, chips, sawdust, rubbish, and water shall be completely removed from the forms by water hosing and air pressure before any concrete is deposited. No wooden ties or blocking shall be left in concrete except where indicated for attachment or other work. The lowest board of forms along walls shall be left loose or cleanout pockets provided. Openings in the forms shall be provided for the introductions of vibrators as necessary. Where required on account of excessive drop, and required by the ENGINEER, the CONTRACTOR shall provide elephant trunks or side openings to receive concrete. Provide a formwork design and placement schedule that will limit free fall of concrete in walls to 6 feet.
- D. 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.

3.5. DEFECTIVE FORMWORK

- A. Variations in alignment in excess of dimensions stated in Section 031000 (1.2) D and E, variations in dimensions that interfere with installation of structure, finish or utilities, or finish surfaces other than as specified shall be considered defective and shall not be approved by the ENGINEER.

3.6. REMOVAL OF FORMS AND SHORING

- A. Forms shall not be removed until permission is obtained from the ENGINEER. No loads shall be placed on any slabs for fourteen (14) days. Forms and shores shall remain undisturbed for a minimum of seven (7) days. Soffit forms of suspended slabs and beams shall remain in place until concrete has attained design strength or until an approved re-shoring system is installed.
- B. Do not remove forms from concrete which has been placed with outside air temperature below 50 degrees F without first determining if the concrete has properly set without regard for time. Do not apply heavy loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.
- C. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and waterstops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2 inches clear.
- D. Wooden wedges only shall be used between the concrete surface and the form where force is necessary to separate the form and the concrete; metal wedges, bars, or striping tools shall not be used for this purpose.

END OF SECTION

SECTION 032000 – CONCRETE REINFORCING

PART 1 – GENERAL

1.1. DESCRIPTION

- A. The CONTRACTOR shall furnish, fabricate, and install all reinforcement steel as shown and specified. The work shall include the furnishing and installation of all tie wires, clips, supports, chairs, spacers, couplers, inserts, and other accessories necessary to produce finished concrete surface in accordance with the Contract Documents.

1.2. RELATED WORK SPECIFIED ELSEWHERE

- A. Section 013323 Submittals
- B. Section 033000 Cast-in-Place Concrete

1.3. REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Codes
 - 1. The Building Code, as referenced herein, shall be the 1997 Uniform Building Code (UBC) of the International Conference of Building Officials (ICBO).
 - 2. ACI 318-99 Building Code Requirements of Reinforced Concrete.
 - 3. ACI 350-01 Code Requirements of Environmental Engineering Concrete Structures.
- B. Commercial Standards (as latest revised)
 - 1. American Concrete Institute (ACI).
 - 2. ACI 315-92 Details and Detailing of Concrete Reinforcement.
 - 3. American Society for Testing and Materials (ASTM), Latest Edition.
 - 4. ASTM A 82 Standard Specifications for Steel Wire, Plain, for Concrete Structures.
 - 5. ASTM A 615 Standard Specifications for Deformed and Plain Billet-Steel Bars for
 - 6. Concrete Reinforcement.

1.4. SUBMITTALS

- A. The CONTRACTOR shall furnish shop bending diagrams, placing lists, bar splices and drawings of all reinforcement steel and concrete inserts prior to fabrication in accordance with Section 013323. Each bending list submitted shall be complete, including corner bars as required. Furnishing such lists shall not be construed that the lists will be reviewed for accuracy. The CONTRACTOR shall be fully responsible for accuracy of dimensions and details, and said dimensions and details will be checked in the field by the ENGINEER at the time of placement. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements specified and shown. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface.

1.5. TEST CERTIFICATES

- A. Mill test certificates shall be submitted to the ENGINEER to certify that the reinforcing steel meets the specified requirements. Mill test certificates shall be furnished and paid for by the CONTRACTOR.
- B. In addition, test samples from the actual material delivered at the site may be taken and test certificates be furnished by a reputable material testing laboratory at the OWNER's expense.

PART 2 – PRODUCTS

2.1. DEFORMED REINFORCING BARS

- A. Unless otherwise specified, reinforcing steel shall be Grade 60 billet steel conforming to ASTM A 615.
- B. Varying grades shall not be used interchangeably in structures.
- C. All such reinforcing shall be deformed steel bars with deformations conforming to the requirements set forth in ASTM Specification A 615.
- D. Steel bending processes shall conform to the requirements of ACI-318.
- E. Bending or straightening shall be accomplished so that the steel will not be damaged.
- F. Kinked bars shall not be used.
- G. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A82, or deformed bars conforming to ASTM A 615.

2.2. HOT-DIPPED GALVANIZED REINFORCED BARS

- A. When reinforcing bars are indicated on the drawings to be hot-dipped galvanized, they shall be galvanized in accordance with ASTM A767 and ASTM A143. The grade of reinforcing bars shall be as specified above. The bars shall be galvanized in conformance with a Class 1 coating and shall be galvanized after fabrication and shearing.

2.3. ACCESSORIES

- A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wire, supports, spacers, and other devices to position reinforcement during concrete placement.
- B. Bar supports shall conform to ACI 315.
- C. Tie wires shall be 18-gage minimum, black, soft annealed.
- D. Bar supports shall consist of approved high density "adobes", stainless steel chairs or plastic spacers, and shim plates (to support spacers for floor and footing reinforcing).
- E. High density adobes shall, as a minimum, be no less in compressive strength or cement content as the concrete in which it will be cast.
- F. Plastic spacers shall be heavy duty PRECO BARSPAN WHEELS, as manufactured by the PRECO CORPORATION (Telephone: 1-(800)-645-1258) or equal.
- G. Steel chairs shall be furnished with plastic tips when incorporated into concrete exposed to view, such as in the roof slab.
- H. The portions of all accessories in contact with the formwork shall be made of concrete, plastic, or steelcoated with 1/8-inch minimum thickness of plastic which extends at least inch from the concrete surface. Plastic shall be gray in color.
- I. Plastic shim plates may be used to support the plastic spacers and shall be used to support the vertical reinforcing in the corewall, unless shown otherwise on the plans.

PART 3 – EXECUTION

3.1. GENERAL

- A. All reinforcing steel and other appurtenances shall be fabricated and placed in accordance with the requirements specified herein and as indicated on the plans.

3.2. FABRICATION

- A. Steel Reinforcement shall be cut and bent in accordance with ACI 318 and with approved practices and machine methods, either at the shop or in the field.
- B. Reinforcing partially embedded in concrete shall not be field bent.
- C. Reinforcement shall be accurately formed to the dimensions indicated on the plans and on the bending schedule.
- D. Bends for hooks on bars shall be made around a pin having a diameter not less than six times the minimum thickness of the bar.
- E. All bars shall be bent cold.

3.3. PLACING

- A. Reinforcing steel shall be accurately positioned as shown and shall be supported and wired together to prevent displacement.
- B. Bars additional to those shown, which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position, shall be provided by the CONTRACTOR at its own expense.
- C. Tie wires shall be bent away from the forms to provide the specified concrete coverage.
- D. All reinforcement shall be retained in place true to indicated lines and grades by the use of approved bar supports.
- E. The supports shall be of sufficient strength and stability to maintain the reinforcement in place throughout the concreting operations. Bar supports shall be placed no further than 4 feet apart in each direction. Supports must be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete.

3.4. BAR SPACING

- A. The clear distance between parallel bars shall not be less than one and one-half times the diameter of the bars and, unless specifically authorized, shall in no case be less than one inch, nor less than the maximum size of coarse aggregate specified.
- B. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.5. CONCRETE COVER (MINIMUM)

- A. On all formed surfaces which will be exposed to water, ground or the elements, there shall be a nominal cover over the steel. of two times the bar diameter or 2.0 inch, whichever is greater, for bars #6- #18, and 1.5 inch for bars #5 and smaller, with an installation tolerance of + 1/4 inch. When crossing bars of different diameter are encountered in one face, one shall consider the bar size and location that will provide the largest cover over the nearest steel to the outside surface.

- B. Unless, otherwise shown on the plans, all reinforcing steel facing subgrades in footing and floors for concrete construction of the reservoir, shall be given a nominal protective cover of 3.0 inch minimum. The largest cover shall be used when different size bars are encountered in one face.
- C. No "burry" or "carrier" bars will be allowed unless specifically approved by the ENGINEER.

3.6. SPLICING

- A. Except as shown by details on the plans, reinforcing steel shall not be spliced at any location without specific approval by the ENGINEER. Splices in adjacent bars shall be staggered.
- B. Where permitted or required., splices in reinforcing steel shall have sufficient lap to transfer full strength of the bar by bond and shear. Unless specified or shown otherwise, the bars at a lap space shall be in contact with each other.
- C. The length of lap for reinforcement bars, unless otherwise shown, shall be in accordance with ACI 350 for a Class B Splice. In no event, shall the lap be less than 40 diameters of the spliced bars.
- D. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.
- E. Unless shown otherwise, where bars are to be lapped spliced at joints in the concrete, all bars shall project from the concrete first placed, a minimum length equal to the lap splice length indicated. All concrete or other deleterious coating shall be removed from dowels and other projecting bars by wire brushing or sandblasting before the bars are embedded in subsequent concrete placement.

3.7. BAR TYING

- A. Bars shall be tied sufficiently often to prevent shifting. There shall be at least three ties in each bar length (this shall not apply to dowel laps or to bars shorter than 4 feet, unless necessary for rigidity).
- B. Slab bars shall be tied at every intersection around the periphery of the slab. Wall bars and slab bar intersections shall be tied at not less than every fourth intersection, but at not greater than the following maximum spacing:

	Slab Bars (inches)	Wall Bars (inches)
Bars No. 5 and smaller	60	48
Bars No. 6 through No. 9	96	60
Bars No. 10 through No. 11	120	96

3.8. REINFORCEMENT AROUND OPENINGS

- A. Where reinforcing steel has to be cut to permit passage of pipe or to create openings, and should no detail be shown for extra reinforcing in such areas, the area of steel removed by the creation of the opening must be replaced by placing at least double the area of steel removed by the opening equally around the openings. The steel shall be placed such that it extends 5 feet beyond the opening on each side to provide for sufficient bond.

3.9. CLEANING AND PROTECTION

- A. At the time of placing concrete, all reinforcement shall be free from loose mill scale, rust, grease, or other coating which might destroy or reduce its bond with concrete.
- B. Steel reinforcement placed in the work shall be stored under cover to prevent rusting and shall be placed on blocking such that no steel touches any ground surface.
- C. All reinforcing steel shall be tied together and supported in such a manner that displacement during placing of concrete and shotcrete will not occur.
- D. When there is a delay in depositing concrete, reinforcement shall be reinspected and cleaned when necessary.

END OF SECTION

SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1. DESCRIPTION

A. Scope:

1. Provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install cast-in-place concrete.
2. The Work includes providing concrete consisting of portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished and cured. The Work also includes:
 - a. Providing openings in concrete to accommodate the Work under this and other Sections and building into the concrete all items such as sleeves, frames, anchor bolts, inserts and all other items to be embedded.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.

C. Classifications of Concrete:

1. Class A (4,000 psi) concrete shall be steel reinforced and includes the following:
 - a. All concrete, unless indicated otherwise.
2. Class B (3,500 psi) concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes the following unless indicated otherwise:
 - a. Concrete fill within structures.
 - b. Duct banks.
 - c. Unreinforced encasements.
 - d. Curbs and gutters.
 - e. Sidewalks.
 - f. Pavement.
 - g. Thrust blocking.
3. Class C (2,000 psi) concrete shall be unreinforced and used where required as concrete fill under foundations, mud slabs, filling abandoned piping and wherever “lean” concrete is required on the Drawings.
4. Class D (350 psi) flowable fill shall be unreinforced and used for filling large underground abandoned spaces and other locations identified in the Drawings.
5. Mass concrete requirements shall apply for the following concrete elements for Class A concrete:
 - a. Wall sections greater than 42-inches thick.

D. Related Sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.2. QUALITY ASSURANCE

A. Qualifications:

1. Mix Designer: Licensed professional ENGINEER registered in the state of California.
2. Batch Plant: Currently certified by the National Ready Mixed Concrete Association.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ACI 207.1R-05, Mass Concrete.
2. ACI 207.2R-07, Effect of Restraint, Volume Change, and Reinforcement on Cracking of Mass Concrete.
3. ACI 207.4R-05, Cooling and Insulating Systems for Mass Concrete.
4. ACI 214, Recommended Practice for Evaluation of Strength Test Results of Concrete.
5. ACI 301, Specifications for Structural Concrete (includes ASTM Standards referred to herein).
6. ACI 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
7. ACI 305, Hot Weather Concreting.
8. ACI 306, Cold Weather Concreting.
9. ACI 309, Guide for Consolidation of Concrete.
10. ACI 311, Guide for Concrete Inspection.
11. ACI 318, Building Code Requirements for Structural Concrete.
12. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
13. ANSI/NSF 61, Drinking Water System Components-Health Effects.
14. AASHTO M 182, Burlap Cloth Made from Jute or Kenaf.
15. AASHTO TP 23, Proposed Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
16. ASTM C 31, Practice for Making and Curing Concrete Test Specimens in the Field.
17. ASTM C 33, Specification for Concrete Aggregates.
18. ASTM C 39, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
19. ASTM C 42, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
20. ASTM C 94, Specification for Ready-Mixed Concrete.

21. ASTM C109, Test Method for Compressive Strength of Hydraulic Cement Mortars.
 22. ASTM C 143, Test Method for Slump of Hydraulic- Cement Concrete.
 23. ASTM C 150, Specification for Portland Cement.
 24. ASTM C 157, Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 25. ASTM C 171, Specification for Sheet Materials for Curing Concrete.
 26. ASTM C 172, Practice for Sampling Freshly Mixed Concrete.
 27. ASTM C 231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 28. ASTM C 260, Specification for Air-Entraining Admixtures for Concrete.
 29. ASTM C 309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 30. ASTM C 330, Specification for Lightweight Aggregates for Structural Concrete.
 31. ASTM C 494, Specification for Chemical Admixtures for Concrete.
 32. ASTM C 618, Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
 33. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 34. ASTM C 1240, Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout.
 35. ASTM E 154, Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
 36. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used for Construction.
 37. ACI 117 Specification for Tolerances for Concrete Construction and Materials.
 38. ACI SP-15 Field Reference Manual
 39. ASTM C138 Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.
 40. ASTM C192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 41. ASTM C900 Standard Test Method for Pullout Strength of Hardened Concrete.
 42. ASTM C928, Standard Specification for Packaged, Dry, Rapid Hardening Cementitious Materials for Concrete Repairs.
- C. Concrete Testing Service:
1. CONTRACTOR shall employ, at its own expense, testing laboratories experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. The same laboratory shall not be employed to both design concrete mixes and provide field testing.

- a. Testing agency shall meet the requirements of ASTM E 329 and ASTM C1077.
 - b. Selection of a testing laboratory is subject to ENGINEER'S approval.
 - c. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information that may be requested by ENGINEER. Field test shall be made by an ACI Concrete Field-Testing Technician Grade I in accordance with ACI CPI, or OWNER approved equal, unless exceptions to field personnel are allowed by the ENGINEER and/or OWNER.
 2. Materials and installed Work may require testing and retesting, as directed by ENGINEER, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be done at CONTRACTOR'S expense, including the retesting of rejected materials and installed Work. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered later nor shall it obligate the OWNER to final acceptance.
- D. Qualifications of Water-Reducing Admixture Manufacturer:
1. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. CONTRACTOR shall furnish copy of manufacturer's quality assurance handbook to document the existence of the program. Manufacturer shall maintain a concrete testing laboratory that has been approved by the Cement and Concrete Reference Laboratory at the Bureau of Standards, Washington, D.C.
 2. Provide a qualified concrete technician employed by the admixture manufacturer to assist in proportioning the concrete for optimum use of the admixture. The concrete technician shall advise on proper addition of the admixture to the concrete and on adjustment of the concrete mix proportions to meet changing jobsite conditions.
- E. Laboratory Trial Batch:
1. Each concrete mix design specified shall be verified by a laboratory trial batch, unless indicated otherwise.
 2. Each trial batch shall include the following testing:
 - a. Aggregate gradation for fine and coarse aggregates.
 - b. Fly ash testing to verify meeting specified properties, unless the fly ash supplier provides certification by an independent testing laboratory.
 - c. Slump.
 - d. Air content.
 - e. Compressive strength based on three cylinders each tested at seven days and at 28 days.
 - f. Shrinkage test as specified herein for Class A concrete mix designs.
 3. Each trial batch shall provide the following information:
 - a. Project identification name and number.

- b. Date of report.
 - c. Complete identification of aggregate source of supply.
 - d. Tests of aggregates for compliance with specified requirements.
 - e. Scale weight of each aggregate.
 - f. Absorbed water in each aggregate.
 - g. Brand, type, and composition of cement.
 - h. Brand, type, and amount of each admixture.
 - i. Amounts of water used in trial mixes.
 - j. Proportions of each material per cubic yard.
 - k. Gross weight and yield per cubic yard of trial mixtures.
 - l. Measured slump.
 - m. Measured air content.
 - n. Compressive strength developed at seven days and 28 days, from not less than three
 - o. Test cylinders cast for each seven-day and 28-day test, and for each design mix.
 - p. Shrinkage test results where required and as specified herein.
4. The requirement for a trial batch may be waived if the required test information has been provided in a previous laboratory trial batch run on the identical mix design within the previous two years. The same brand, type, and source of all materials must have been used.
- F. Shrinkage Test:
- 1. Drying shrinkage tests will be made for the trial batch as specified herein.
 - 2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10-inches, fabricated, cured, dried, and measured in accordance with the requirements of ASTM C 157 modified as follows: specimens shall be removed from molds at an age of 23 ± 1 hours after trial batching, shall be placed immediately in water at 70°F
 - 3. $\pm 3^{\circ}\text{F}$ for at least 30 minutes and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$. Measurement to determine expansion expressed as a percentage of original length shall be made at age seven days. This length at age seven days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$ and 50 percent ± 4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after seven days of moist curing.

4. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001-inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as specified in Part 2, herein.
- G. Sample Panels:
1. Provide sample panels of wall finishes, 12-inches by 12-inches by 3-inches thick. Perform revisions and corrective work required to produce finished concrete and surfaces as required by ENGINEER.
 - a. Construct additional sample panels as may be required if original results are not satisfactory.
 2. The continuity of color and texture for exposed concrete surfaces is of prime importance. Maintain such controls and procedures, in addition to those specified, as is necessary to provide continuous match of concrete Work with accepted samples.
- H. Mock-up Panels:
1. Fabricate mock-up panels representative of specified finished surfaces after sample form panels are approved, at locations on the site as directed by ENGINEER. Form, reinforce, mix, cast, cure and finish mock-up panels using selected materials and construction methods proposed for the Work. Provide mock-up panels as follows:
 - a. Wall section of "L"-shaped panels, approximately 4 feet high by 3 feet each side by 8-inches thick and set on an 18-inch wide by 8-inch thick base, unless otherwise shown. Form faces to represent each specified formed surface finish. Include not less than two form ties, two form panel intersections, one vertical construction joint and one horizontal construction joint. Construction joints are specified in Section 03251, Concrete Joints, of these Specifications.
 - b. Column section, approximately four feet high and not less than 12-inches diameter for round sections and not less than 12-inches in least dimension for rectangular sections for each specified formed finish, unless otherwise shown. Set column sections on a 6-inch thick concrete base which extends 8-inches beyond the column. Chamfer exposed edges of rectangular sample columns.
 - c. Slab-on-grade section, approximately four feet square and a minimum of 4-inches thick for each applied finish, with at least one construction joint and one expansion joint, if used.
 2. Reinforce mock-up panels as required to prevent cracking and to be structurally stable or as shown on the Drawings. Reinforcing steel shall not be less than 0.25 percent of the gross concrete cross section in each direction.

3. Protect mock-up panels from damage and do not remove them without written permission from ENGINEER. When directed, demolish mock-up panels and remove from the site.

1.3. SUBMITTALS

- A. Samples: Submit samples of materials as specified and as otherwise may be requested by ENGINEER, including names, sources and descriptions. Submittal data shall demonstrate compliance with all requirements of this specification. Any deviations from the specifications shall be clearly noted in the submittal and justification presented for the deviation.
- B. Shop Drawings: Submit for approval the following:
 1. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures, bonding agents and repair materials.
 2. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs.
 3. The following information, if ready-mixed concrete is used.
 - a. Physical capacity of mixing plant.
 - b. Trucking facilities available.
 - c. Estimated average amount that can be produced and delivered to the site during a normal eight-hour day, excluding the output to other customers.
 4. Manufacturer's Certificate of Compliance:
 - a. Portland Cement.
 - b. Admixtures.
 - c. Fly Ash.
 - d. Aggregates.
 - e. Bonding Agent.
 - f. Bond Breakers.
 - g. Patching Materials.
 - h. Admixtures: Manufacturers' Certificate of Proper Installation.
- C. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. ENGINEER'S review will be for general information only. Production of concrete to comply with specified requirements is the responsibility of CONTRACTOR.
- D. Submit notarized certification of conformance to referenced standards when requested by ENGINEER.
- E. Delivery Tickets: Furnish to OWNER representative copies of all delivery tickets for each load of concrete at the time of delivery to the site. Provide items of information as specified in ASTM C 94, Section 16.1.
- F. Administrative Submittals: Concrete Coordination Meeting Minutes.

- G. Qualifications of Finishes: Submit qualifications of the finishing CONTRACTOR and the finishers who will perform the Work.
- H. Drawings: Submit concrete placement drawings showing the lift numbers, locations of all joints, concrete mix design being placed, concrete finishes, and all pertinent embedded items including embed plates and angles, sleeves, pipes, conduits, anchors, gate thimbles, etc. Where the Drawings permit the CONTRACTOR to select joint locations, show the selected dimensions on the placement drawings. Approval of the placement drawings shall not relieve the CONTRACTOR of the responsibility of placing all required embedments as specified and where shown in the Drawings. Submit information for acceptance of proposed construction joints not otherwise shown in the Drawings.
- I. Submit notification of placement to the OWNER's representative at least 24 hours in advance of concrete placement.
- J. Submit a work plan for cold weather concreting and hot weather concreting describing proposed methods and procedures for complying with the requirements of this specification.
- K. Mass Concreting:
 - 1. Heat Flow Analysis: Prior to construction, the CONTRACTOR shall submit a heat flow analysis for mass concrete elements which calculates the maximum allowable concrete temperature (internal) in accordance with ACI 207.2R and the maximum allowable temperature differential in accordance with ACI 207.1R. The calculation shall be performed well in advance of construction to allow for revisions to concrete mix designs when required. The analysis shall be based on the design assumption that cracking as a result of heat of hydration during concrete curing shall not occur. Calculations shall be sealed by a registered engineer and shall consider means and methods proposed by the CONTRACTOR for construction jointing, specified section thicknesses, and arrangement of structural elements.
 - 2. The CONTRACTOR shall submit a Thermal Control Plan for mass concrete elements to include, as a minimum, the following:
 - a. Concrete mix design used in the heat flow analysis.
 - b. Duration and methods of curing for each mass concrete element.
 - c. Procedures for controlling concrete temperatures at the time of placement.
 - d. Methods for controlling temperature differentials within the concrete placement.
 - e. Temperature sensor system used to measure internal concrete temperatures and temperature differentials.
 - f. Field measures to ensure conformance with the maximum concrete temperature and temperature differential requirements.
 - 3. Where method of precooling of concrete is obtained by Liquid Nitrogen (LN) mix injection, CONTRACTOR shall submit plan for injection procedures, source and supplier of LN, written safety plan alerting workers as to potential dangers of LN exposures and plan of action in case of LN spill or pipe break.

1.4. PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling, and handling to ensure that segregation of the coarse and fine aggregate particles does not occur and that the grading is not affected. Ensure that product delivery of concrete conforms to the requirements of ASTM C94 and ACI 304.
- B. Cementitious Materials: Store cementitious materials in dry, weather tight buildings, bins or silos that will exclude contaminants.
- C. Aggregates: Store and handle aggregates in a manner that will avoid segregation and prevent contamination with other materials or other sizes of aggregates. Store aggregates to drain freely.
- D. Water and Ice: Protect mixing water and ice from contamination during storage and delivery.
- E. Admixtures: Protect stored admixtures against contamination, evaporation, or damage. Provide agitating equipment for admixtures used in the form of suspensions or nonstable solutions to ensure thorough distribution of the ingredients. Protect liquid admixtures from freezing and from temperature changes that effect their characteristics. Comply with all manufacturer guidelines for proper storage and handling of the material.

1.5. CONCRETE COORDINATION MEETING

- A. A Concrete Coordination Meeting shall be held to review the detailed requirements of CONTRACTOR'S proposed concrete design mixes, to determine the procedures for producing proper concrete construction, and to clarify the roles of the parties involved shall be held no later than 14 days after the Notice to Proceed.
- B. All parties involved in the concrete Work shall attend the meeting, including but not limited to the following:
 - 1. CONTRACTOR'S representative.
 - 2. Testing laboratory representative.
 - 3. Concrete subcontractor.
 - 4. Reinforcing steel subcontractor and detailer.
 - 5. Concrete supplier.
 - 6. Admixture manufacturer's representative.
 - 7. ENGINEER and OWNER.
- C. The Concrete Coordination Meeting shall be held at a mutually agreed upon time and place. The ENGINEER shall be notified no less than five days prior to the date of the Concrete Coordination Meeting.

PART 2 – PRODUCTS

2.1. CEMENTITIOUS MATERIALS

- A. Cement:
 - 1. Portland cement, ASTM C 150, Type I/II.

2. Use portland cement made by a well-known acceptable manufacturer and produced by not more than one plant. Alternate cement sources may be used provided that a mix design has been accepted and a trial batch verifying performance has been made. All cement shall be produced by the dry-kiln process. CONTRACTOR shall provide written certification of the production of cement by the dry-kiln process.
 3. Do not use cement which has deteriorated because of improper storage or handling.
- B. Fly Ash Mineral Admixture:
1. Mineral admixtures, when used, shall meet the requirements of ASTM C 618 Class F, except as follows:
 - a. The loss on ignition shall be a maximum of 4 percent.
 - b. The maximum percent of sulfur trioxide (SO₃) shall be 4.0.
 2. Fly ash shall be considered to be a cementitious material.
 3. Laboratory trial batches shall be tested to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.
 4. A substitution by weight, of the portland cement by fly ash, so that the total tricalcium aluminate content of the resulting cement plus fly ash is not greater than eight percent, will be considered. However, the fly ash shall not exceed 15 percent by weight of the cement plus fly ash for Class A concrete, nor 25 percent for Class B and C concrete. For Mass Concrete, fly ash replacement shall not exceed 25% by weight of the cement plus fly ash unless the mix designer can substitute use of higher percentages through past mix design applications acceptable to the ENGINEER.

2.2. AGGREGATES

- A. General: Aggregates shall conform to the requirements of ASTM C 33 and as herein specified.
1. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.
- B. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
1. Dune sand, bank run sand and manufactured sand are not acceptable.
- C. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
1. Crushed stone processed from natural rock or stone.
 2. Washed gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.
- D. The grading of the combined aggregate shall meet the following requirements:
1. Not more than 75 or less than 50 percent of the combined aggregate that is retained on the No. 8 sieve shall also be retained on the 3/8-inch sieve.

2. The percent of the combined aggregate passing No. 8 sieve shall not be less than 34 nor more than 40 percent of the combined aggregate for mixtures that contain 564 lbs./yd³ of cementitious materials content. For every 94 lb. variation from 564 lbs. add or deduct 2.5 percent from the percent passing the No. 8 sieve. The higher the amount of cementitious materials, the less the amount of aggregate passing the No.8 sieve aggregate required for mixture mobility and vice versa.
3. The percent of the combined aggregate retained on any two consecutive sieves shall not be less than 14 percent of the combined aggregate.

2.3. WATER AND ICE

- A. Mixing water and ice, including reprocessed water, used in the production and curing of concrete shall meet the requirements of ASTM C94 and shall be clean and free from injurious amounts of oils, acids, alkalis, organic materials or other substances that may be deleterious to concrete or steel.

2.4. CONCRETE ADMIXTURES

- A. Provide admixtures produced by established reputable manufacturers, and use in compliance with the manufacturer's printed instructions. All admixtures shall be compatible and by a single manufacturer capable of providing qualified field service representation. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by ENGINEER.
- B. Air-Entraining Admixtures: ASTM C 260.
 1. Product and Manufacturer: Provide one of the following:
 - a. Sika Corporation.
 - b. BASF.
 - c. W.R. Grace & Company.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
 1. Proportion all Class A and Class B concrete with non-air entraining, normal setting,
 2. water-reducing, aqueous solution of a modification of the salt of polyhydroxylated organic acids. The admixture shall not contain any lignin, nitrates or chlorides added during manufacture.
 3. Product and Manufacturer: Provide one of the following:
 - a. Euclid Chemical Company.
 - b. BASF.
 - c. W.R. Grace & Company.
 - d. Sika Corporation.
- D. High Range Water-Reducing Admixture (HRWR): ASTM C 494, Type F/G.

1. High range water-reducer shall be used in classifications of concrete, where specified, and shall be permitted, at CONTRACTOR'S option, in all other classifications of concrete. It shall be added to concrete in compliance with the manufacturer's printed instructions. The specific admixture formulation shall be as recommended by the manufacturer for the project conditions. Provide one of the following:
 - a. Sika Corporation.
 - b. BASF.
 - c. W.R. Grace & Company.
 - d. Euclid Chemical Company.
- E. Set-Control Admixtures: ASTM C 494, as follows:
 1. Type B, Retarding.
 2. Type C, Accelerating.
 3. Type D, Water-reducing and Retarding.
 4. Type E, Water-reducing and Accelerating.
 5. Type F, Water-reducing, high range admixtures.
 6. Type G, Water-reducing, high range, and retarding admixtures.
- F. Calcium Chloride: Calcium chloride shall not be used.
- G. Shrinkage Reducing Admixture
 1. A shrinkage reducing admixture shall be permitted to be used in the mix design where necessary to meet specified shrinkage limitations provided that specified strength requirements are met and there is no reduction in sulfate resistance and no increase in permeability.
 2. Shrinkage reducing admixtures shall be one of the following:
 - a. Grace Construction Products.
 - b. BASF.
- H. If superplasticizers are used in mix designs, the mix shall be slumped at site prior to addition of plasticizer.
- I. Corrosion Inhibiting Admixtures
 1. Corrosion inhibiting admixture shall be a calcium nitrite solution containing a minimum of 30 percent calcium nitrite. It shall be added at a dosage rate of five gallons per cubic yard of concrete.
 2. The quantity of mix water shall be adjusted to account for the water portion of the calcium nitrite solution.
 3. As the calcium nitrite solution accelerates setting time, retarding admixtures shall be provided as required.
 4. Product and Manufacturer: Provide one of the following:
 - a. Grace Construction Products.
 - b. BASF.

c. Euclid Chemical Company.

2.5. PROPORTIONING AND DESIGN OF MIXES

- A. Prepare concrete design mixes subject to the following minimum limitations. The final mix design proportions shall be developed by the supplier and shall meet the requirements of this specification:

Classification	Coarse Aggregate ¹		Minimum Cementitious (lbs/cy)	Maximum W/C Ratio ⁴	Slump ²	Air (%)	Minimum Compressive Strength ³ (psi)
	Size A	Size B					
Class “A”	#57	#8	567	0.45	4” Max	5 +/- 1.5	4000
Class “B”	#57 or #67		517	.50	4” Max	5 +/- 1.5	3500
Class “C”	Any ASTM C 33		no requirements				2000
Class “D”	no requirements						300

- Coarse aggregate size numbers refer to ASTM C 33. Where a size A and B are listed, it is intended that the smaller size B aggregate is to be added, replacing a portion of the coarse and/or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with a sand content not exceeding 41 percent of total aggregate.
 - The slumps listed are prior to the addition of high range water reducer (super plasticizer).
 - Mix designs shall be made for all but Class C, which does not require a trial batch, so that the compressive strength achieved for the laboratory trial batches will be no less than 125 percent of the specified design strength. This is to assure meeting the design strength for all concrete batched during the project. Design compressive strength shall be based on 28-day strengths except strengths for Mass Concrete elements shall be based on 56-day strengths.
 - The quantity of water to be used in the determination of the water-cementitious materials ratio shall include free water on aggregates in excess of SSD and the water portion of admixtures.
- B. Use an independent testing facility acceptable to ENGINEER for preparing and reporting proposed mix designs.
- The testing facility shall not be the same as used for field quality control testing.
- C. Submit written reports of laboratory trial batch test results for proposed mixes of concrete to ENGINEER at least 15 days prior to start of Work. Do not begin concrete production until mixes have been approved by ENGINEER.
- D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by CONTRACTOR when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the OWNER and as accepted by ENGINEER. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by ENGINEER before using the revised mixes.
- E. Admixtures:
- Use air-entraining admixture in all concrete, unless otherwise shown or specified. Add

2. air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the prescribed limits.
 3. Water reducing or high-range water reducing admixtures shall be used in all Class A concrete.
 4. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.
- F. Slump Limits with High Range Water Reducer
1. Slump shall not exceed that specified in item A above prior to adding high range water-reducer and shall not exceed 7.5 inches, measured at point of placement, after adding high range water reducer.
- G. Shrinkage Limitation
1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.039 percent or 0.045 percent, respectively. CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to Class A concretes.
 2. If the trial batch results fail to meet the shrinkage limitation, the mix shall be redesigned to reduce shrinkage. Alternately, CONTRACTOR may use a higher shrinkage mix when acceptable to the ENGINEER provided that the amount of shrinkage reinforcement in the structures is increased as determined by the ENGINEER to resist the higher levels of shrinkage stresses. The additional reinforcing shall be provided at CONTRACTOR'S expense.
- H. Size of Coarse Aggregate: The nominal maximum size of coarse aggregate shall be one-inch but not exceed three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between side forms, or one-third of the thickness of slabs or toppings.

2.6. CONCRETE CURING MATERIALS

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.
- B. Curing Mats: Curing mats shall be heavy carpets or cotton mats, quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.
- C. Moisture Retaining Cover: One of the following, complying with ASTM C 171.
 1. Waterproof paper.
 2. Polyethylene film.
 3. White burlap-polyethylene sheet.
- D. Curing Compound: ASTM C 309 Type 1-D (water retention requirements):
 1. Provide fugitive dye.
 2. Product and Manufacturer: Provide one of the following:

- a. Super Aqua Cure VOX, as manufactured by The Euclid Chemical Company.
 - b. Sealtight 1100, as manufactured by W.R. Meadows, Incorporated.
 - c. MasterKure, as manufactured by BASF.
3. Curing compound must be applied by roller or power sprayer.

2.7. FINISHING AIDS

A. Evaporation Retardant:

1. Product and Manufacturer: Provide one of the following:
 - a. Confilm, as manufactured by BASF.
 - b. Eucobar, as manufactured by Euclid Chemical Company.
 - c. SikaFilm by Sika Corporation.

2.8. CRACK INJECTION MATERIALS

A. Epoxy:

1. Epoxy for injection shall be a low viscosity, high modulus moisture insensitive type.
2. Products and Manufacturers: Provide one of the following:
 - a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, as manufactured by Sika Corporation.
 - b. Eucopoly Injection Resin, as manufactured by The Euclid Chemical Company.

B. Hydrophilic Resin

1. Hydrophilic resin shall be an acrylic-ester based resin with a maximum viscosity of 50 cps. It shall cure into a flexible rubber-like material that has the potential for unrestrained increase in volume in excess of 100 percent in the presence of water.
2. Products and Manufacturers: Provide one of the following:
 - a. Duroseal Inject, as manufactured by BBZ USA, Inc.
 - b. Sika Injection 29, by Sika Corporation.

2.9. CONCRETE REPAIR MATERIALS

A. Concrete repair mortar shall be a prepackaged polymer-modified cementitious repair mortar with the following minimum properties:

1. Compressive strength at one day: 2000 psi (ASTM C 109).
2. Compressive strength at 28 days: 6000 psi (ASTM C 109).
3. Bond strength at 28 days: 1800 psi (ASTM C 882 modified).

B. Concrete repair mortar shall be:

1. Five Star Structural Concrete, manufactured by Five Star Products, Inc. The formulation recommended by the manufacturer for the specific application conditions shall be used.

2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, manufactured by the Sika Corporation. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
 3. MasterEmaco S488 CI or S466 CI manufactured by Master Builders Inc. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
 4. Verticoat, Verticoat Supreme, or Euco SR-VO, manufactured by the Euclid Chemical Company, The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
- C. Cement Mortar: Cement mortar shall consist of a mix of one part cement to 1 1/2 parts sand with sufficient water to form a trowelable consistency. Minimum compressive strength at 28 days shall be 4000 psi. Where required to match the color of adjacent concrete surfaces, white portland cement shall be blended with standard portland cement so that, when dry, the patching mortar shall match the color of the surrounding concrete.

2.10. MOISTURE BARRIER

- A. Moisture Barrier: ASTM E 154:
1. Provide moisture barrier cover over prepared base material or carton void form at all buildings and where shown on the Drawings. Use polyethylene membrane not less than 10 mils thick, lapping at least 9-inches at joints.

2.11. MASS CONCRETE MONITORING SYSTEM

- A. The temperature monitoring and recording system for Mass Concrete elements shall consist of temperature sensors connected to a data acquisition system capable of printing, storing and downloading data to a computer. Monitoring system shall be obtained from a reputable source with at least 3-years prior experience of mass concrete monitoring. Acceptable monitoring systems are as follows:
1. Intellirock Concrete Maturity and Temperature Monitoring System; Engius LLC, Stillwater, OK; www.engius.com.
 2. Or ENGINEER approved equal.

PART 3 – EXECUTION

3.1. INSPECTION

- A. CONTRACTOR shall examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2. CONCRETE MIXING

- A. General:

1. Concrete may be produced at batch plants or it may be produced by the ready-mixed process. Batch plants shall comply with the recommendations of ACI 304 and shall have sufficient capacity to produce concrete of the qualities specified, in quantities required to meet the construction schedule. All plant facilities are subject to testing laboratory inspection and acceptance of the OWNER.
2. Mixing:
 - a. Mix concrete with an approved rotating type batch machine, except where hand mixing of very small quantities may be permitted.
 - b. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.
 - c. Replace mixer blades when they have lost ten percent of their original height.
 - d. Use quantities such that a whole number of bags of cement is required, unless otherwise permitted.
- B. Ready-Mix Concrete:
 1. Comply with the requirements of ASTM C 94, and as herein specified. Proposed changes in mixing procedures, other than herein specified, must be accepted by ENGINEER before implementation.
 - a. Plant equipment and facilities: Conform to National Ready-Mix Concrete Association "Plant and Delivery Equipment Specification".
 - b. Mix concrete in revolving type truck mixers that are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
 - c. Do not exceed the proper capacity of the mixer.
 - d. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
 - e. Do not allow the drum to mix while in transit.
 - f. Mix at proper speed until concrete is discharged.
 - g. Maintain adequate facilities at the job site for continuous delivery of concrete at the required rates.
 - h. Provide access to the mixing plant for ENGINEER at all times.
- C. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.

3.3. TRANSPORTING CONCRETE

- A. Transport and place concrete not more than 90 minutes when ambient temperatures are below 80 degrees and 60 minutes when temperatures are above 80 degrees, after water has been added to the dry ingredients. Any time beyond that specified is subject for immediate rejection by the OWNER's representative.
- B. Take care to avoid spilling and separation of the mixture during transportation.

- C. Do not place concrete in which the ingredients have been separated.
- D. Do not retemper partially set concrete.
- E. Use suitable and approved equipment for transporting concrete from mixer to forms.
- F. Transport and deliver concrete in equipment conforming to ASTM C94.

3.4. PREPARATION FOR CONCRETING

- A. All reinforcement, installation of waterstop and positioning of embedded items shall be inspected and approved by the OWNER's representative a minimum of four hours prior to concrete placement.
- B. Subgrade surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.
- C. All reinforcing steel and embedded items shall be completely cleaned of mortar, loose rust, form release compounds, dirt, or any other substance which would interfere with proper bonding with concrete. Protective coatings on embedded aluminum items shall continuously cover the surface to be in contact with concrete. Any defects in the coating shall be repaired.
- D. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater nor shall CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the ENGINEER.
- E. Joint surfaces shall be prepared as required by Section 03 15 16, Concrete Joints.

3.5. CONCRETE PLACEMENT

- A. General: Place concrete continuously so that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified in Section 03 15 16, Concrete Joints. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure which will cause segregation.
 - 1. Screed concrete that is to receive other construction to the proper level to avoid excessive skimming or grouting.
 - 2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.
 - 3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and secure position.

4. Do not place footings in freezing weather unless adequate precautions are taken against frost action.
 5. Do not place footings, piers or pile caps on frozen soil.
 6. Unless otherwise approved, place concrete only when ENGINEER is present.
 7. Allow a minimum of three days before placing concrete against a slab or wall already in place.
- B. Bonding for Next Concrete Pour:
1. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:
 - a. Thoroughly wet the surface, but allow no free standing water.
 - b. For horizontal surfaces place a 2-inch layer of mortar, one part sand and one part cement with water added to a flowable consistency, or a 6-inch layer of Construction Joint Grout, as specified in Section 03 60 00, Grout, over the hardened concrete surface.
 - c. Place fresh concrete before the mortar/grout has attained its initial set.
 - d. If a high range water reducer is used to increase the concrete slump to at least 6-inches, the mortar/grout layer may be omitted.
 2. Bonding of fresh concrete to fully-cured hardened existing concrete shall be accomplished by using a bonding agent as specified in Section 03 15 16, Concrete Joints.
- C. Concrete Conveying:
1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods that will prevent segregation and loss of concrete mix materials.
 2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.
 3. Do not use chutes for distributing concrete, unless approved in writing by ENGINEER.
 - a. Provide sketches showing methods by which chutes will be employed when requesting such approval.
 - b. Design chutes, if permitted, with proper slopes and supports to permit efficient handling of the concrete.
 4. Pumping concrete is permitted, however do not use aluminum pipe for conveying.
- D. Placing Concrete into Forms:
1. Deposit concrete in forms in horizontal layers not deeper than 18-inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place concrete at such a rate that concrete that is being integrated with fresh concrete is still plastic.

2. Do not permit concrete to free fall within the form from a distance exceeding four feet. Where high range water reducer is used to extend slump to at least 6- inches, the maximum free fall of concrete may be increased to six feet. If a 12-inch thick layer of construction joint grout, as specified in Section 03 15 16, Concrete Joints, is placed on the horizontal joint, concrete with slump extended by a high range water reducer may free fall up to eight feet in walls that are 24-inches and thicker. Use "elephant trunks" to prevent free fall and excessive splashing on forms and reinforcement. Free falls in excess of four feet shall be discontinued if there is any evidence of segregation.
3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the applicable recommended practices of ACI 309. Vibration of forms and reinforcing will not be permitted, unless otherwise accepted by ENGINEER.
5. Where height of concrete placement in walls exceeds 8 feet, temporary windows shall be installed in the formwork to facilitate vibration. The windows shall be properly closed when the height of concrete approaches the windows. Location, size, and spacing of the windows shall be determined by CONTRACTOR to suit equipment used.
6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6-inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
7. Do not place concrete in beam and slab forms until the concrete previously placed in columns and walls is no longer plastic.
8. Force concrete under pipes, sleeves, openings and inserts from one side until visible from the other side to prevent voids.
9. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
10. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
11. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified for formed concrete structures.
12. Bring slab surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

13. Where slabs are placed in conditions of high temperature or wind that could lead to formation of plastic shrinkage cracks, an evaporation retardant shall be applied in accordance with the manufacturer's recommendations, when required by the ENGINEER.

E. Quality of Concrete Work:

1. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.
2. All concrete for liquid retaining structures, and all concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
3. Cut out and properly replace to the extent directed by ENGINEER, or repair to the satisfaction of ENGINEER, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Thin patches or plastering shall not be acceptable.
4. All leaks through concrete that exhibit any flowing water, and cracks, holes or other defective concrete in areas of potential leakage, shall be repaired and made watertight by CONTRACTOR.
5. Repair, removal, and replacement of defective concrete as directed by ENGINEER shall be at no additional cost to the OWNER.

F. Cold Weather Placing:

1. Protect all concrete Work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.
2. When the air temperature has fallen to or may be expected to fall below 40°F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50°F and 70°F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to ensure that the ambient temperature does not fall more than 30°F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
3. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55°F and not more than 85°F at point of placement.
4. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.
5. Do not use salt and other materials containing antifreeze agents or chemical accelerators, or set-control admixtures, unless approved by ENGINEER, in mix designs.

G. Hot Weather Placing:

1. For conventional concrete:

- a. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
- b. When ambient air temperature is at or above 85°F, cool ingredients before mixing to maintain concrete temperature at the time of placement below 90°F for horizontal placements including slabs and flatwork, and below 95°F for vertical placements including walls and columns. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated in the total amount of mixing water. In addition, the reduction in time from addition of mix water to placement or the use of a set retarding admixture may be required.
- c. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
- d. Wet forms thoroughly before placing concrete.
- e. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.
- f. Do not use set-control admixtures, unless approved by ENGINEER in mix designs.
- g. Obtain ENGINEER'S approval of other methods and materials proposed for use.
2. For Mass Concrete, meet the requirements for conventional concrete above with the following exceptions and limitations:
 - a. When ambient air temperature is at or above 85°F, cool ingredients before mixing to maintain concrete temperature at time of placement below 85°F. Methods of cooling may include:
 - (i) Mixing water may be chilled, or chipped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated in the total amount of mixing water and shall not exceed 50 percent of the total mix water weight.
 - (ii) Inject Liquid Nitrogen (LN) into the mix at batching. Amount of LN to be used shall consider the amount of concrete being batched and the distance the concrete must be transported.

H. Mass Concrete Temperature Monitoring

1. Concrete temperature sensors shall be located such that the maximum temperature difference within a Mass Concrete element can be monitored. As a minimum, concrete temperatures shall be monitored at the calculated hottest location on at least two outer faces, two corners and top surfaces. Temperature readings shall be recorded on an hourly basis. A redundant set of sensors shall be installed near the primary sensors. Comparisons between the primary and redundant sensors shall be monitored for consistency. Temperature readings shall be maintained until the following three requirements are satisfied:
 - a. The internal peak temperature is reached and begins to decline.

- b. The difference between interior concrete temperature and the average daily ambient temperature is less than the allowable temperature difference (40 degrees F) for three consecutive days.
- c. There are no mass concrete elements to be cast directly adjacent.
- 2. Temperature recordings shall be submitted daily to the OWNER's field representative.

3.6. FINISH OF FORMED SURFACES

A. Standard Form Finish:

- 1. Standard form finish shall be basically smooth and even but shall be permitted to have texture imparted by the form material used. Defects shall be repaired as specified herein.
- 2. Use standard form finish for the following:
 - a. Exterior vertical surfaces from the foundation up to one foot below grade.
 - b. Vertical surfaces not exposed to view.
 - c. Other areas shown.

B. Smooth Form Finish:

- 1. Produce smooth form finish by selecting form materials that will impart a smooth, hard, uniform texture. Arrange panels in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas as specified herein.
- 2. Use smooth form finish for the following:
 - a. Exterior surfaces that are exposed to view.
 - b. Surfaces that are to be covered with a coating material. The material may be applied directly to the concrete or may be a covering bonded to the concrete such as waterproofing, dampproofing, painting or other similar system.
 - c. Interior vertical surfaces of liquid containers.
 - d. Interior and exterior exposed beams and undersides of slabs.
 - e. Surfaces to receive an abrasive blasted finish.
 - f. Surfaces to receive a smooth rubbed or grout cleaned finish.
 - g. Other areas shown.

C. Smooth Rubbed Finish:

- 1. Provide smooth, Class A, rubbed finish to concrete surfaces, which have received smooth form finish and where all defects have been repaired, as follows:
 - a. Rubbing of concrete surfaces not later than the day after form removal.
 - b. Moistening of concrete surfaces and rubbing with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
- 2. Except where surfaces have been previously covered as specified above, use smooth, Class A, rubbed finish for the following:

- a. Interior exposed walls and other vertical surfaces.
- b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
- c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
- d. Interior exposed vertical surfaces of liquid containers down to one foot below liquid level.
- e. Other areas shown on the Drawings.

D. Abrasive Blasted Finish

1. Provide abrasive blasted finish where shown on the Drawings.
2. Where abrasive blasted finish is indicated, it shall be applied to a smooth formed finish after the end of the curing period, with all defects repaired, to match the approved finish provided on the mock-up panel.
3. Heavy Abrasive Blasted Finish: Abrasive blast to uniformly expose coarse aggregate.
4. Light Abrasive Blasted Finish: Abrasive blast to uniformly expose fine aggregate.

E. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.7. SLAB FINISHES

A. Float Finish:

1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently. Check and level the surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.
2. Use float finish for the following:
 - a. Interior exposed horizontal surfaces of liquid containers, except those to receive grout topping.
 - b. Exterior below grade horizontal surfaces.
 - c. Surfaces to receive additional finishes, except as shown on the Drawings or specified.

B. Trowel Finish:

1. After concrete has stiffened sufficiently to permit operation and after bleed water has disappeared, hand or machine float the surface. Follow immediately by steel troweling at least twice with hand or machine trowels.

2. Consolidate the concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten foot straight edge. Grind smooth surface defects that would telegraph through applied floor covering system.
 3. Use trowel finish for the following:
 - a. Interior exposed slabs, unless otherwise shown or specified.
 - b. Slabs to receive resilient floor finishes.
- C. Non-Slip Broom Finish:
1. Immediately after float finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fine fiber-bristle broom, unless otherwise directed by the ENGINEER. Coordinate the required final finish with ENGINEER before application.
 2. Use Non-Slip Broom Finish for the following:
 - a. Exterior exposed horizontal surfaces subject to light foot traffic.
 - b. Interior and exterior concrete steps and ramps.
 - c. Horizontal surfaces which will receive a grout topping or a concrete equipment base slab.

3.8. CONCRETE CURING AND PROTECTION

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
2. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from the concrete surface. Keep continuously moist for not less than 72 hours. At the end of this period, initial curing may be terminated and final curing begun.
3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least seven days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least ten days. For concrete sections over 30-inches thick, continue final curing for an additional seven days, minimum. Avoid rapid drying at the end of the final curing period.

B. Curing Methods:

1. Water retaining and below grade structures shall be moist cured by the addition of water to maintain the surface in a continually wet condition. Other concrete shall be cured by moist curing, by moisture retaining cover curing, or by the use of curing compound (except where coatings or surface treatments are specified). Use curing compound at water retaining and below grade structures only in cold weather when temperatures are expected to be below freezing only when permitted by ENGINEER.

- a. For curing, use water that is free of impurities that could etch or discolor exposed, natural concrete surfaces.
 2. Provide moisture curing by any of the following methods:
 - a. Keeping the surface of the concrete continuously wet by covering with water.
 - b. Continuous water-fog spray.
 - c. Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent mats. If necessary, the curing cover shall be weighted to maintain contact with the concrete surface.
 - d. At the end of the curing period apply one coat of curing compound, unless concrete surface is to receive a topping or coating or application is waived by the ENGINEER.
 3. Provide moisture retaining cover curing as follows:
 - a. Cover the concrete surfaces with the specified moisture retaining cover for curing concrete, placed in the widest practical width with sides and ends lapped at least 3-inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
 4. Provide liquid curing compound as follows:
 - a. Apply the specified curing compound to all concrete surfaces when permitted by ENGINEER. Slabs to receive terrazzo floors, chemical resistant heavy duty concrete topping or ceramic tile or chemical hardeners, shall not be cured with liquid curing compound, but shall be moisture cured. The compounds shall be applied immediately after final finishing in a continuous operation by power spray equipment in accordance with the manufacturer's directions. Recoat areas that are subjected to heavy rainfall within three hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period
 - b. When curing compound is authorized for application to water retaining or below grade members, it shall be applied at the manufacturer's recommended coverage rate and then applied again at the same rate to provide twice the recommended coverage.
 - c. At the end of the curing period, curing compound shall be removed where required by the ENGINEER.
- C. Curing Formed Surfaces:
 1. Cure formed concrete surfaces, including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place unloosened for the full curing period or until forms are removed. Where wood forms are kept in place, water shall be added to keep the forms wet. If forms are removed, continue curing by methods specified above, as applicable.
- D. Curing Unformed Surfaces:

1. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by using the appropriate method specified above.
 2. Final cure unformed surfaces, unless otherwise specified, by utilizing methods specified above, as applicable.
- E. Temperature of Concrete During Curing:
1. When the atmospheric temperature is 40°F and below, maintain the concrete temperature between 50°F and 70°F continuously throughout the curing period. When necessary, make arrangement before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protection complying with the requirements of ACI 306.
 2. When the atmospheric temperature is 80°F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protection complying with the requirements of ACI 305, unless otherwise specified.
 3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5°F in any one hour and 40°F in any 24 hour period. Provide necessary heating or cooling as required to prevent such temperature changes.
 4. Mass Concrete: Meet the requirements specified in Item 3 above and the following exceptions and limitations.
 - a. The maximum allowable internal concrete temperature during curing shall not exceed 150°F at the calculated hottest point in the concrete as determined in the Heat Flow Analysis.
 - b. The maximum allowable temperature differential between the calculated hottest point in the concrete and the concrete surface shall be as determined in the Heat Flow Analysis but shall not exceed 40°F.
 - c. Insulating curing blankets shall be used on all Mass Concrete elements to provide for thermal protection. Thermal insulating blankets shall be left in place until each of the following are satisfied:
 - (i) Temperature readings shall be maintained until the internal peak temperature is reached and begins to decline.
 - (ii) The difference between interior concrete temperature and the average daily ambient temperature is less than the allowable temperature difference (40 degrees F) for three consecutive days.
 - (iii) There are no mass concrete elements to be cast directly adjacent.
- F. Protection from Mechanical Injury:

1. During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.9. FIELD QUALITY CONTROL

A. Quality Control Testing During Construction:

1. Perform sampling and testing for field quality control during the placement of concrete, as follows:
 - a. Sampling Fresh Concrete: ASTM C 172.
 - b. Concrete sampling for quality assurance: Concrete that is to be pumped or conveyed by bucket or crane shall be sampled at the point of discharge from the truck for information, including slump; and shall be sampled at the point of placement for acceptance of slump and air content.
 - c. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
 - d. Air Content: ASTM C 231; one for every other concrete load at point of discharge, or when required by an indication of change.
 - e. Compressive Strength Tests: ASTM C 39; one set of compression cylinders for each 50 cubic yards or fraction thereof, of each mix design placed in any one day; one specimen tested at seven days, and three specimens tested at 28 days. For Mass Concrete elements, additional sets shall be obtained to determine compressive strengths at 56, 90 and 120 days, and one reserve cylinder for later testing directed by the OWNER. Cylinders for Mass Concrete shall be 6-inch x 12-inch cylinders containing concrete wet screened to 1- 1/2-inch maximum size. Correlation tests shall be made well in advance of actual construction to compare the strength of the wet screened concrete tested at control age with appropriate size test specimen containing the full mass concrete tested at design age.
 - (i) Adjust mix if test results are unsatisfactory and resubmit for ENGINEER'S approval.
 - (ii) Concrete that does not meet the strength requirements is subject to rejection and removal from the Work, or to other such corrective measures as directed by ENGINEER, at the expense of CONTRACTOR.
 - f. Compression Test Specimens: ASTM C 31; make one set of four standard cylinders for each compressive strength test, unless otherwise directed by the ENGINEER.
 - (i) Cast, store and cure specimens as specified in ASTM C 31.
 - g. Water Cementitious Materials Ratio: Perform one test from each sample from which compression test specimens are taken in accordance with AASHTO TP 23.
 - h. Concrete Temperature: Test hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens is made.

2. The testing laboratory shall submit certified copies of test results directly to ENGINEER and CONTRACTOR within 24 hours after tests are made.
 3. Representatives of the following testing agency will inspect, sample, and/or test materials. When it appears that the material furnished or work performed fails to conform to the Contract Documents, the testing agency will immediately report such deficiency to the OWNER's representative, ENGINEER, and CONTRACTOR.
 4. The testing agency and its representative are not authorized to revoke, alter, relax, or release any requirements of the Contract Documents, nor to accept any portion of the Work.
 5. The testing agency will report test and inspection results that pertain to the Work to the ENGINEER, CONTRACTOR and OWNER's representative within 7 days after tests and inspections are performed.
 6. Other Testing Services: The CONTRACTOR shall pay for the following testing services performed, when necessary and/or requested by the OWNER:
 - a. Additional testing and inspection required due to changes in materials or mixture proportions requested by the CONTRACTOR.
 - b. Additional testing of materials or concrete due to failure to meet requirements of the Contract Documents.
- B. Evaluation of Quality Control Tests:
1. Do not use concrete delivered to the final point of placement, which has slump or total air content outside the specified values.
 2. When water content testing indicates water-cementitious materials ratio to exceed specified requirements by more than 0.02, remaining batches needed to complete the concrete placement shall have water content decreased in the mix and water reducing admixture dosage increased as needed to bring the subsequently batched concrete within the specified water-cementitious materials ratio. Additional testing shall be done to verify compliance with the specified water-cementitious materials ratio. Concrete production for further concrete placements shall not resume until CONTRACTOR has identified the cause of the excess water in the mix and revised batching procedures and/or adjustments to mix design needed to bring water-cementitious materials ratio into conformance with specified requirements have been accepted by the ENGINEER.
 3. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength tests results equal or exceed the 28 day design compressive strength of the type or class of concrete; and, no individual strength test falls below the required compressive strength by more than 500 psi.
 - a. Where questionable field conditions may exist during placing concrete or immediately thereafter, strength tests of specimens cured under field conditions will be required by ENGINEER to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded at the same time and from the same samples as the laboratory cured specimens.

- (i) Provide improved means and procedures for protecting concrete when the 28 day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders.
 - (ii) When laboratory-cured cylinder strengths are appreciably higher than the minimum required compressive strength, field-cured cylinder strengths need not exceed the minimum required compressive strength by more than 500 psi even though the 85 percent criterion is not met.
 - (iii) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to assure that the load-bearing capacity of the structure is not jeopardized. If the likelihood of low-strength concrete is confirmed and computations indicate the load-bearing capacity may have been significantly reduced, tests of cores drilled from the area in question will be required at CONTRACTOR'S expense.
 - b. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to replacement, reconstruction or to other action approved by ENGINEER.
 - 4. For Mass Concrete elements, compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength tests results equal or exceed the 56-day design compressive strength of the class of concrete by no more than 500 psi; and no individual strength test falls below the required compressive strength by more than 500 psi. Control specimens developed at the beginning of the Project will be used for comparison to strength tests at 56 days. Where continued strength gain is shown in the control cylinders at later stages of curing, the CONSULTING ENGINEER may use the control specimen values in evaluation of field cylinders.
- C. Testing Concrete Structure for Strength:
- 1. When there is evidence that the strength of the in-place concrete does not meet specification requirements, CONTRACTOR shall employ at its expense the services of a concrete testing service to take cores drilled from hardened concrete for compressive strength determination. Tests shall comply with the requirements of ASTM C 42 and the following:
 - a. Take at least three representative cores from each member or suspect area at locations directed by ENGINEER.
 - b. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85 percent and no single core is less than 75 percent of the 28-day required compressive strength.

- c. Report test results to ENGINEER, in writing, on the same day that tests are made. Include in test reports, the Project Identification Name and Number, date, name of CONTRACTOR, name of concrete testing service, location of test core in the structure, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of the concrete as placed, and the moisture condition of the core at time of testing.
2. Fill core holes solid with non-shrink, high strength grout, and finish to match adjacent concrete surfaces.
3. Conduct static load test and evaluations complying with the requirements of ACI 318 if the results of the core tests are unsatisfactory, or if core tests are impractical to obtain, as directed by ENGINEER.

3.10. MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings

1. Openings in concrete walls and/or slabs required for passage of Work or installation of equipment and not shown on the Drawings shall be provided, but only with approval of the ENGINEER.
2. All temporary openings made in concrete shall be provided with waterstop in below grade or water retaining members. Continuity of required reinforcement shall be provided in a manner acceptable to the ENGINEER.
3. Temporary openings left in concrete structures shall be filled with concrete after the Work causing the need for the opening is in place, unless otherwise shown or directed by the ENGINEER. Mix, place and cure concrete as specified herein, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the Work.

B. Equipment Bases:

1. Unless specifically shown otherwise, provide concrete bases for all pumps and other equipment. CONTRACTOR shall coordinate and construct bases to the dimensions shown, or as required to meet manufacturers' requirements and Drawing elevations. Where no specific elevations are shown, bases shall be 6-inches thick and extend 3-inches outside the metal equipment base or supports. Bases shall have smooth trowel finish, unless a special finish such as terrazzo, ceramic tile or heavy duty concrete topping is required. In those cases, provide appropriate concrete finish.
2. Include all concrete equipment base work not specifically included under other Sections.
3. In general, place bases up to 1-inch below the metal base. Properly shim equipment to grade and fill 1-inch void with non-shrink grout as specified in Section 03 60 00, Grout.

C. Curbs:

1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
2. Exterior curbs shall have rubbed finish for vertical surfaces and a broomed finish for top surfaces.

3.11. CONCRETE REPAIRS

A. Repair of Formed Surfaces:

1. The following defects shall be repaired in all types of formed finishes:
 - a. Spalls, bugholes, honeycombs, air bubbles, rock pockets, form depressions, and other defects that are more than 1/4-inch in depth.
 - b. Holes from tie rods and other form tie systems.
 - c. Fins, offsets and other projections that extend more than 1/4-inch beyond the designated member surface.
 - d. Structural cracks, as defined by the ENGINEER.
 - e. Non-structural cracks, as defined by the ENGINEER, which are greater than 0.010-inch wide. In water retaining members, elevated slabs subject to rainfall and washdown, and below grade members, any crack that shows any amount of leakage. Where it is not possible to verify that a crack is not leaking, it shall be repaired.
2. The following defects shall be repaired in smooth finish surfaces, in addition to those listed above:
 - a. Spalls, air bubbles, bugholes, honeycombs, rock pockets, form depressions, and other defects which extend to more than 1/2-inch in width in any direction, no matter how deep.
 - b. Spalls, air bubbles, rock pockets, form depressions, and other defects of any size that exceed three in number in a 12-inch square or 12 in number in a three foot square.
 - c. Fins, offsets and other projections shall be completely removed and smoothed.
 - d. Scratches and gouges in the surface.
 - e. Texture and color irregularities. At water retaining surfaces, texture and color irregularities need not be repaired when greater than 12-inches below the minimum normal operating water surface, except where such defects are indicative of reduced durability.
3. Where a smooth rubbed or grout cleaned finish is specified, minor surface defects repairable by the finishing process need not be repaired prior to the finish application, when approved by the ENGINEER.

B. Method of Repair of Formed Surfaces:

1. Repair and patch defective areas with cement mortar or concrete repair mortar immediately after removal of forms and as directed by ENGINEER. Repairs made to water bearing and buried surfaces shall be made with repair mortar only. Repairs of form tie holes on water bearing or buried surfaces shall be made with non-shrink grout as specified in Section 03 60 00, Grout.
 2. Cut out honeycomb, rock pockets, voids, and holes left by tie rods and bolts, down to solid concrete but, in no case, to a depth of less than 1-inch for cement mortar and 1/2-inch for repair mortar. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean and brush-coat the area to be patched with the specified bonding agent. Where concrete repair mortar is used, bonding agent shall be optional and the surface prepared and mortar placed per manufacturers recommendations.
 - a. Repairs at exposed-to-view surfaces shall match the color of surrounding concrete, except color matching is not required for the interior surfaces of liquid containers up to one foot below liquid level. CONTRACTOR shall impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.
 3. Structural cracks shall be pressure grouted using an injectable epoxy using a pumped pressure system. Apply in accordance with the manufacturer's directions and recommendations.
 4. Non-structural cracks shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.
 5. Determination of the crack type shall be made by the ENGINEER.
 6. Fill holes extending through concrete by means of a plunger- type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure completely filling. At below grade and water retaining members, fill holes with concrete repair mortar except use a color matched cement mortar for the outer 2-inches at exposed to view surfaces.
 7. Where powerwashing and/or scrubbing is not adequate, abrasive blast exposed-to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.
- C. Repair of Unformed Surfaces:
1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.
 2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.

3. Repair finish of unformed surfaces that contain defects that adversely affect the durability of the concrete. Surface defects include crazing, cracks in excess of 0.01-inch wide, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
4. Repair structural cracks in all structures and non-structural cracks in water-holding structures. In water-holding structures, where the dry face of the concrete member can be observed, cracks that show any rate of water flow shall be repaired. Where the dry face of the member cannot be observed, all cracks shall be repaired.

D. Methods of Repair of Unformed Surfaces:

1. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
2. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Where the concrete has already set and repairs are required, sawcut around the perimeter of the area to be repaired to a 1/2-inch depth and remove concrete so that the minimum thickness of the repair is 1/2-inch. Apply specified concrete repair mortar in accordance with the manufacturer's directions and recommendations.
3. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. The minimum thickness of the repair shall be 1.5-inches. Dampen all concrete surfaces in contact with patching concrete and brush with the specified bonding agent. Place patching concrete while the bonding agent is still tacky. Mix patching concrete of the same materials and proportions to provide concrete of the same classification as the original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
4. Repair isolated random non-structural cracks (in members which are not below grade or water retaining), and single holes not over 1-inch diameter, by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.
5. Structural cracks shall be pressure grouted using an injectable epoxy. Apply in accordance with the manufacturer's directions and recommendations.
6. Non-structural cracks in below grade and water retaining structures shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.
7. Determination of the crack type shall be made by the ENGINEER.

8. Assure that surface is acceptable for flooring material to be installed in accordance with manufacturer's recommendations.
- E. Other Methods of Repair:
 1. Repair methods not specified above may be used if approved by ENGINEER.

END OF SECTION

SECTION 036000 – GROUTING

PART 1 – GENERAL

1.1. WORK IN THIS SECTION

- A. The CONTRACTOR shall provide grout in accordance with the Contract Documents.
- B. The following types of grout shall be covered in this Section:
 - 1. Nonshrink Grout: This type of grout is to be used wherever grout is shown in the Contract Documents, unless another type is specifically referenced.
 - 2. Cement Grout
 - 3. Epoxy Grout
 - 4. Pump and Motor Grout

1.2. RELATED SECTIONS

- A. The Work of the following Sections apply to the Work of this Section. Other Sections, not referenced below, shall also apply to the extent required for proper performance of this Work.
 - 1. Section 033000 Cast-in-Place Concrete

1.3. REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Except as otherwise indicated, the current editions of the following standards apply to the work of this Section:
 - 1. Commercial Standards:
 - a System for Concrete
 - ASTM C 882 Standard Test for Bond Strength of Epoxy-Resin Systems Used with Concrete
 - ASTM C 884 Standard Test Method for Thermal Compatibility between Concrete and an Epoxy-Resin Overlay
 - ASTM D 638 Standard Test Methods for Tensile Properties of Plastics
 - ASTM D 696 Test Method for Coefficient of Linear Thermal Expansion of Plastics
 - ASTM D 2471 Standard Test Methods for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins

1.4. CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit certified test results verifying the compressive strength, shrinkage, and expansion requirements indicated herein; and manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of nonshrink and epoxy grout used in the Work in accordance with the requirements of Section 013323 – Submittals.

1.5. QUALITY ASSURANCE

- A. Field Tests:

1. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the OWNER to ensure continued compliance with these Specifications. The specimens will be made by the OWNER.
 2. Compression tests and fabrication of specimens for cement grout and nonshrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the OWNER. A set of three specimens will be made for testing at 7 days, 28 days, and each additional time period as appropriate.
 3. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the OWNER. A set of three specimens will be made for testing at 7 days, and each earlier time period as appropriate.
 4. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the OWNER.
 5. The cost of all laboratory tests on grout will be borne by the OWNER, but the CONTRACTOR shall assist the OWNER in obtaining specimens for testing. However, the CONTRACTOR shall be responsible, without additional cost to the OWNER, for the cost of any additional tests and investigation on work performed which does not comply with the Specifications. The CONTRACTOR shall supply all materials necessary for fabricating the test specimens.
- B. Construction Tolerances: Construction tolerances shall be as specified in the Section 033000 Cast-in-Place Concrete, except as modified herein and elsewhere in the Contract Documents

PART 2 – PRODUCTS

2.1. CEMENT GROUT

- A. Cement Grout: Cement grout shall be composed of one part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4,000 psi.
- B. Cement grout materials shall be as specified in Section 033000 - Cast-in-Place Concrete.

2.2. PREPACKAGED GROUTS

- A. Nonshrink Grout:
 1. Nonshrink grout shall be a prepackaged, inorganic, nongas-liberating, nonmetallic, cement-based grout requiring only the addition of water. The manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of nonshrink grout indicated herein shall be that recommended by the manufacturer for the particular application.

2. Class A nonshrink grouts shall have a minimum 28-day compressive strength of 5,000 psi; shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C 827; and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state when tested in accordance with CRD-C 621.
 3. Class B nonshrink grouts shall have a minimum 28-day compressive strength of 5,000 psi and shall meet the requirements of CRD-C 621.
 4. Application:
 - a. Class A nonshrink grout shall be used for the repair of all holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under all equipment base plates, and at all locations where grout is indicated; except, for applications for Class B nonshrink grout and epoxy grout indicated herein. Class A nonshrink grout may be used in place of Class B nonshrink grout for all applications.
 - b. Class B nonshrink grout shall be used for the repair of all holes and defects in concrete members which are not water-bearing and not in contact with soil or other fill material, grouting under all base plates for structural steel members, and grouting railing posts in place
- B. Epoxy Grout:
1. Epoxy grout shall be a pourable, nonshrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any nonreactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. Epoxy grout shall be BurkEpoxy Anchoring Grout by The Burke Company.
 2. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.
 3. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F.
 4. The epoxy grout shall develop a compressive strength of 5,000 psi in 24 hours and 10,000 psi in 7 days when tested in accordance with ASTM C 579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C 827.
 5. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by a test consisting of filling a 2-inch diameter by 4-inch high metal cylinder mold covered with a glass plate coated with a release agent. A weight shall be placed on the glass plate. At 24 hours after casting, the weight and plate shall be removed and the area in plan of all voids measured. The surface of the grout shall be probed with a sharp instrument to locate all voids.

6. The peak exotherm of a 2-inch diameter by 4-inch high cylinder shall not exceed 95 degrees F when tested with 75-degree F material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30×10^{-6} inches/inch/degree F when tested according to ASTM C 531 or ASTM D 696.
 7. Application: Epoxy grout shall be used to embed all anchor bolts and reinforcing steel required to be set in grout, and for all other applications in the Contract Documents where grout type is not specifically indicated.
 8. For crack repair, the CONTRACTOR shall use pressure injection epoxy grout as recommended by manufacturer and approved by the OWNER.
- C. Grout for Pumps and Motors:
1. Grout for pumps and motors shall be epoxy grouts meeting the following minimum requirements.
 - a. Creep shall be less than 0.005 in/in when tested by ASTM C 881 method. The test shall be at 70 degrees F and 140 degrees F with a load of 400 psi.
 - b. Linear shrinkage shall be less than 0.080 percent and thermal expansion less than 17×10^{-6} in/in/degree F when tested by ASTM C 531.
 - c. The compressive strength shall be a minimum of 12,000 psi in 7 days when tested by ASTM C 579 Method 8, modified.
 - d. Bond strength of grout to portland cement concrete shall be greater than 2,000 psi when using ASTM C 882 test method.
 - e. Grout shall pass the thermal compatibility test when overlaid on portland cement concrete using test method ASTM C 884.
 - f. Tensile strength and modulus of elasticity shall be determined by ASTM D 638. The tensile strength shall not be less than 1,700 psi and the modulus of elasticity shall not be less than 1.8×10^6 psi.
 - g. Gel time and peak exothermic temperature shall be determined by ASTM D 2471. Peak exothermic temperature shall not exceed 110 degrees F when a specimen 6 inches in diameter by 12 inches high is used. Gel time shall be at least 150 minutes.
 - h. The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperatures as high as 150 degrees F, with a load of 2,000 psi.
 2. Primer, if required, shall conform to the written recommendations of the grout manufacturer.
 3. Surface preparations shall conform to the written recommendations of the grout manufacturer.
 4. Placement and Curing:
 - a. Placement and curing procedures shall be in accordance with the written recommendations of the grout manufacturer.

- b. A grouting performance demonstration/training session shall be conducted by the grout manufacturer's representative prior to foundation and baseplate preparation and the first grouting on site. This training session shall demonstrate proper preparation and installation methods and that the grouting material meets the strength requirements.
- 5. Grout shall be Escoweld, Chockfast Red Epoxy Grout as manufactured by Philadelphia Resin Corp., Five Start DP Epoxy Grout as manufactured by Five Star Products, Inc., or equal.

2.3. TOPPING GROUT AND CONCRETE FILL

- A. Grout for topping of slabs and concrete fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as specified herein. All materials and procedures specified for normal concrete in Section 033000 -Cast-in-Place Concrete, shall apply except as noted otherwise herein.
- B. Topping grout and concrete fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Where concrete fill is thicker than 3 inches, sitework concrete, as specified in Section 033000 - Cast-in-Place Concrete, may be used when accepted by the OWNER.
- C. Coarse aggregate shall be graded as follows:

<u>U.S. Standard Sieve Size</u>	<u>Percent by Weight Passing</u>
2"	100
3/8"	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

- D. Final mix design shall be as determined by trial mix design under supervision of the approved testing laboratory.
 - E. Strength: Minimum compressive strength of topping grout and concrete fill at the end of 28 days shall be 4,000 psi.

2.4. CURING MATERIALS

- A. Curing materials shall be as specified in Section 033000 -Cast-in-Place Concrete for cement grout and as recommended by the manufacturer of prepackaged grouts.

2.5. MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 – EXECUTION

3.1. GENERAL

- A. All surface preparation, curing, and protection of cement grout shall be as indicated in Section 033000 - Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete.
- B. The manufacturer of Class A nonshrink grout and epoxy grout shall provide onsite technical assistance to CONTRACTOR upon request.
- C. Base concrete or masonry must have attained its design strength before grout is placed, unless authorized by the OWNER.
- D. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.
- E. The slump for topping grout and concrete fill shall be adjusted to match placement and finishing conditions but shall not exceed 4 inches.

3.2. GROUTING PROCEDURES

- A. Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- B. Base Plate Grouting:
 - 1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum 1-inch thickness of grout or a thickness as indicated on the Drawings.
 - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout. The mixture shall be of a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the backside of the space to be filled with grout. Where this method of placement is not practical or where required by the OWNER, alternate grouting methods shall be submitted for acceptance by the OWNER.
- C. Topping Grout and Concrete Fill:
 - 1. All mechanical, electrical, and finish Work shall be completed prior to placement of topping or concrete fill. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.
 - 2. The minimum thickness of grout topping and concrete fill shall be one inch unless otherwise specified on drawings. Where the finished surface of concrete fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2-inches wide by 1-1/2 inches deep.

3. The base slab shall be thoroughly cleaned and wetted prior to placing topping or concrete fill. No topping or concrete fill shall be placed until the slab is complete free from standing pools or ponds of water. A thin coat of neat Type II cement grout shall be broomed into the surface of the slab just before topping or concrete fill placement. The topping or concrete fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted concrete fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.
4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straightedge to detect high and low spots that shall be immediately eliminated. When the topping or concrete fill have hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

3.3. CONSOLIDATION

- A. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

END OF SECTION

SECTION 260000 – ELECTRICAL GENERAL PROVISIONS

PART 1 – GENERAL

1.1. SCOPE

- A. Furnish all labor, materials and equipment required to install, test and provide an operational, electrical system as specified herein and as shown on the Drawings.
- B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.
- C. All electrical work provided under any Division of the Specifications shall fully comply with the requirements of Division 26.
- D. The work shall include furnishing, installing and testing the equipment and materials detailed in each Section of Division 26.
- E. The work shall include furnishing and installing the following:
 - 1. Provide a complete raceway system, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions. Coordinate construction schedule and electrical interface with the supplier of electrical equipment specified under other Divisions as required by the Contract Documents.
 - 2. Provide a complete raceway system, wiring and terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators and control panels. Lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions as required by the Contract Documents.
 - 3. Furnish and install precast electrical and instrumentation manholes, handholes and light pole foundations as required by the Contract Documents. Pole foundations shall be designed and installed in accordance with the structural Divisions of these Specifications.
 - 4. Provide standby generation, if needed, to keep Owner's process in service as required by the Contract drawings.
- F. Power System Study
 - 1. See Section 260573.19: Arc Flash Hazard Analysis

1.2. ELECTRICAL WORK REQUIRED IN OTHER DIVISIONS

- A. No references are made to any other section which may contain work related to any other section. The Contract Documents, which is defined to include both the Drawings and the Specifications, shall be taken with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, provide such information or additional work as may be required in those references, and include such information or work as may be specified. Examine all Sections of the Specifications and Drawings and determine the power and wiring requirements and provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, provide the additional conductors, raceways and/or wiring, and include in the Contract Price and Schedule.
- B. Process Divisions
 - 1. The Contractor shall be responsible for examining all Process Equipment Specifications and Drawings, determining power and wiring requirements and providing external wiring and raceways, as required to provide a fully functioning Process Control System. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, at no cost to the Owner.
- C. Mechanical Divisions
 - 1. The Contractor shall be responsible for examining all Mechanical Equipment Specifications and Drawings, determining power and wiring requirements and providing external wiring and raceways, as required to provide fully functioning Mechanical Equipment Control Systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring at no cost to the Owner.
- D. Electric Valve Operator Divisions
 - 1. The Contractor shall be responsible for examining all Electric Valve Operator Equipment Specifications and Drawings, determining power and wiring requirements and providing external wiring and raceways, as required to provide a fully functioning Electric Valve Operator Control System. If the equipment requires more conductors and/or wiring due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring at no cost to the Owner.
- E. Other
 - 1. All required electrical work not shown on electrical drawings provided under the section of the specification requiring the work and shall comply with the requirements of Division 26.

1.3. SUBMITTALS

- A. Submit Shop Drawings, in accordance with Division 1 requirements, for equipment, materials and all other items furnished under each Section of Division 26, except where specifically stated otherwise. An individually packaged submittal shall be made for each Section, and shall contain all of the information required by the Section. Partial submittals will not be accepted and will be returned unreviewed.
- B. Submittals will not be accepted for Section 26 00 00.
- C. Each Section submittal shall be complete, contain all of the items listed in the Specification Section, and shall be clearly marked to indicate which items are applicable on each cut sheet page. The Submittal shall list any exceptions to the Specifications and Drawings, and the reason for such deviation. Shop drawings, not so checked and noted, will be returned unreviewed.
- D. The Contractor shall check shop drawings for accuracy and contract requirements prior to submittal to the Owner/Engineer. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and Drawings. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to Specifications and Drawings. Only one Specification Section may be made per transmittal.
- E. Submittal Attachments
 - 1. Include with each submittal a copy of the relevant specification section, including relevant addendum updates.
 - a. Indicate in the left margin, next to each pertinent paragraph, either N/A for not applicable, compliance with a check (✓), or deviation with a consecutive number (1, 2, 3).
 - b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
- F. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED CONFIRM", "APPROVED AS NOTED AND RESUBMIT", "REVISE AND RESUBMIT", "REJECTED", or "NOT APPROVED".
- G. At the time of jobsite delivery of the equipment, the Contractor shall have an approved shop drawing in his possession for the Owner's Inspector and Owner's Engineer, for verification
- H. Up-to-date Record Drawings shall be promptly furnished when the equipment installation is complete. Payment will be withheld until Record Drawings have been furnished and approved.
- I. All shop drawing submittals and all O&M submittals shall be submitted in hard copy format and in electronic format using PDF files including a Table of Contents which is indexed on DVDs. Electronic submittals are mandatory and those which are received not indexed as specified will be returned without review. Hard copy submittals may not be required if so stipulated in the Contract Documents. No change in Contract Amount or Contract Time will be allowed for delays due to unacceptable submittals.

1.4. REFERENCE CODES AND STANDARDS

- A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC) and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
 2. Occupational Safety and Health Administration (OSHA)
 3. National Fire Protection Association (NFPA).
 4. National Electrical Manufacturers Association (NEMA)
 5. American National Standards Institute (ANSI)
 6. Insulated Cable Engineers Association (ICEA)
 7. Instrument Society of America (ISA)
 8. Underwriters Laboratories (UL)
 9. Factory Mutual (FM)
 10. City of Bridgeport Electrical Code
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- D. D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Owner/Engineer. The determination of precedence shall be the Engineer's alone and shall be binding on the Contractor.
- E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times.

1.5. HAZARDOUS AREAS

- A. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503.
- B. Equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classification.
- C. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NFPA standards.

1.6. CODES, INSPECTION AND FEES

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all necessary permits and pay all fees required for permits and inspections.

- C. Contractor shall make all arrangements with Local electric utility for obtaining electrical service, pay all power company charges, complete all necessary forms and furnish all labor and material required for the electrical service.

1.7. SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

1.8. RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings". The Record Drawings and Specifications shall be kept up to date throughout the project.
- B. The Record Drawings shall be reviewed in a meeting with the Owner/Engineer on a monthly basis.
- C. Record Drawings shall accurately show the installed condition of the following items:
 - 1. One-line Diagram(s).
 - 2. Raceways and pullboxes, including duct banks and manholes.
 - 3. Conductor sizes and conduit fills.
 - 4. Panel Schedule(s).
 - 5. Control Wiring Diagram(s).
 - 6. Lighting Fixture Schedule(s).
 - 7. Lighting fixture, receptacle and switch outlet locations.
 - 8. Underground raceway and duct bank routing indicating width and burial depth.
 - 9. Site plan indicating actual alignment of all overhead power line routing, including pole locations.
 - 10. Plan view, sizes and locations of switchgear, distribution transformers, substations, motor control centers and panelboards.
- D. Submit a typical example of a schedule of control wiring raceways and wire numbers, including the following information:
 - 1. Circuit origin, destination and wire numbers.
 - 2. Field wiring terminal strip names and numbers.
- E. As an alternate, submit a typical example of point-to-point connection diagrams showing the same information, may be submitted in place of the schedule of control wiring raceways and wire numbers.
- F. Submit the record drawings and the schedule of control wiring raceways and wire numbers (or the point-to-point connection diagram) to the Owner/Engineer.

- G. The Contractor's retainage shall not be paid until the point-to-point connection diagrams have been furnished to the Owner/Engineer.

1.9. EQUIPMENT INTERCONNECTIONS

- A. Review shop drawings of equipment furnished under other related Divisions and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with Record Drawings.
- B. Furnish and install all equipment interconnections.

1.10. MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.
- B. The Contractor shall not bring onsite, material or equipment from a manufacturer, not submitted and approved for this project. Use of any such material or equipment, will be rejected, removed and replaced by the Contractor, with the approved material and equipment, at his own expense.
- C. Material and equipment shall be UL listed, where such listing exists.
- D. The Contractor shall be responsible for all material, product, equipment and workmanship being furnished by him for the duration of the project. The Contractor shall replace the equipment if it does not meet the Contract Documents.

1.11. JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.
- B. Equipment and materials shall be handled and stored in accordance with the manufacturer's instructions, and as specified in the individual Specification Sections.

1.12. WARRANTIES

- A. Manufacturer's warranties shall be as specified in each of the Specification Sections.

1.13. EQUIPMENT IDENTIFICATION

- A. Identify equipment (disconnect switches, separately mounted motor starters, control stations, etc) furnished under Division 26 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1. INTERPRETATION OF DRAWINGS

- A. The Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

- B. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.
- C. Unless otherwise approved by the Owner/Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.
- D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation.
- E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
- F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Owner/Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Owner/Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown.
- H. Redesign of electrical or mechanical work, which is required due to the Contractor's use of a preapproved alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Owner/Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.
- I. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low voltage power and signal systems as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Refer to riser diagrams for signal system wiring. Homeruns, as shown on the Drawings, are to assist the Contractor in identifying raceways to be run exposed and raceways to be run concealed. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes hoists, monorails, equipment hatches, doors, windows, etc. Raceways installed concealed shall be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.
- J. The Contractor shall run all conduit and wire to RTU and/or PLC termination cabinets, where designated on the Drawings. The conduit and wire as shown on the interface drawings may not necessarily be shown on the floor plan.
- K. Install conductors carrying low voltage signals (typically twisted shielded pair or Ethernet cables) in raceways totally separate from all other raceways containing power or 120 volt control conductors.
- L. Raceways and conductors for thermostats controlling HVAC unit heaters, exhaust fans and similar equipment are not shown on the Drawings. Provide raceways and conductors between the thermostats, the HVAC equipment and the motor starters for a complete and operating system. All raceways and power conductors shall be in accordance with Division 26. Raceways shall be installed concealed in all finished space and may be installed concealed or exposed in process spaces. Refer to the HVAC drawings for the locations of the thermostats and controls.

3.2. EQUIPMENT PADS AND SUPPORTS

- A. Not all electrical equipment pads and supports, of concrete or steel including structural reinforcing and lighting pole foundations, are shown on the Structural Drawings.
- B. No electrical equipment or raceways shall be attached to or supported from, sheet metal walls.

3.3. SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.
- B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Owner/Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.
- D. Seal all openings, sleeves, penetration and slots as specified in Section 26 05 33.

3.4. CUTTING AND PATCHING

- A. Coordinate with Divisions 2 and 3 for cutting and patching.
- B. Core drill holes in concrete floors and walls as required. The Contractor shall obtain written permission from the Owner/Engineer before core drilling any holes larger than 2 inches.
- C. Install work at such time as to require the minimum amount of cutting and patching.
- D. Do not cut or core drill through joists, beams, girders, columns or any other structural members.
- E. Cut opening only large enough to allow easy installation of the conduit.
- F. Patching shall be of the same kind and quality of material as was removed.
- G. The completed patching work shall restore the surface to its original appearance or better.
- H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.
- I. Remove rubble and excess patching materials from the premises.
- J. When existing conduits are cut at the floor line of wall line, they shall be filled with grout of suitable patching material.

3.5. INSTALLATION

- A. Any work not installed according to the Drawings and this Section shall be subject to change as directed by the Owner/Engineer. No extra compensation will be allowed for making these changes.
- B. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- C. Electrical equipment shall be protected at all times against mechanical injury or damage by water. Electrical equipment shall not be stored outdoors. Electrical equipment shall be stored in dry permanent shelters as required by each Specification Section. Do not install electrical equipment in its permanent location until structures are weather-tight. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and tested as directed by the Owner/Engineer, or shall be replaced at no additional cost at the Owner/Engineer's discretion.

- D. Equipment which has been damaged shall be replaced or repaired by the equipment manufacturer, at the Owner/Engineer's discretion.
- E. Repaint any damage to the factory applied paint finish using touch-up paint furnished by the equipment manufacturer. If the metallic portion of the panel or section is damaged, the entire panel or section shall be replaced, at no additional cost to the Owner.
- F. Penetration through the top of any NEMA 3R, 4, or 4X enclosure is strictly prohibited. Any enclosure so penetrated shall be removed and replaced at no increase in the contract price or change in contract time.

3.6. PHASE BALANCING

- A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on motor control centers and panelboards shall be field connected to result in evenly balanced loads across all phases.
- B. Field balancing of circuits shall not alter the conductor color coding requirements as specified in

3.7. MANUFACTURER'S SERVICE

- A. Provide manufacturer's services for testing and start-up of the equipment as listed in each individual Specification Section. All settings, including those settings and arc flash labels required by the Power System Study conducted by the engineer, shall be made to the equipment and approved by the Owner/Engineer prior to energizing of the equipment.
- B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturers warranty repairs.

3.8. TESTS AND SETTINGS

- A. Testing shall be done in accordance with NETA Standards. Acceptable third-party testing companies are:
 - 1. Real Power
 - 2. National Switchgear
 - 3. Shermco
- B. Test systems and equipment furnished under Division 26 and repair or replace all defective work. Make adjustments to the systems as specified and/or required.
- C. Prior to energizing electrical equipment, make all tests as required by the individual specification Sections. Submit a sample test form or procedure and submit the required test reports and data to the Owner/Engineer for approval at least two weeks prior to the startup of the tested equipment. Include names of all test personnel and initial each test.
- D. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.
- E. Check wire and cable terminations for tightness.
- F. Check rotation of motors prior to energization. Disconnect driven equipment if damage could occur due to wrong rotation. If the motor rotates in the wrong direction, the rotation shall be immediately corrected, or tagged and locked out until rotation is corrected.

- G. Verify all terminations at transformers, equipment, capacitor connections, panels, and enclosures by producing a 1 2 3 rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.
- H. Mechanical inspection, testing and setting of circuit breakers, disconnect switches, motor starters, control equipment, etc for proper operation.
- I. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by schematic and wiring diagrams.
- J. Check the ampere rating of thermal overloads for motors and submit a typed record to the Owner/Engineer of same, including MCC cubicle location and load designation, motor service factor, horsepower, full load current and starting code letter. If inconsistencies are found, new thermal elements shall be supplied and installed.
- K. Verify motor power factor capacitor ratings.
- L. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment.
- M. Refer to the individual equipment sections for additional specific testing requirements.
- N. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

3.9. TRAINING

- A. The Contractor shall provide manufacturer's training as specified in each individual section of the Specifications.

END OF SECTION

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Special Provisions Sections, apply to this Section.

1.2. SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3. ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 – PRODUCTS

2.1. CONDUCTORS AND CABLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following or equal:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. Alpha Wire.
 - 3. Belden Inc.
 - 4. Encore Wire Corporation.
 - 5. General Cable Technologies Corporation.
 - 6. Southwire Incorporated.
- B. 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/THWN-2.
- D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for armored cable, Type AC, metal-clad cable, Type MC with ground wire.

2.2. CONNECTORS AND SPLICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following or equal:
 - 1. AFC Cable Systems, Inc.
 - 2. Gardner Bender.
 - 3. Hubbell Power Systems, Inc.

4. Ideal Industries, Inc.
- B. IlSCO; a branch of Bardes Corporation.
 1. NSi Industries LLC.
 2. O-Z/Gedney; a brand of the EGS Electrical Group.
 3. 3M; Electrical Markets Division.
 4. Tyco Electronics.
- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3. 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.
- B. Comply with NFPA 70.

PART 3 – EXECUTION

3.1. CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper Solid for No. 8 AWG and smaller; stranded for No. 6 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 8 AWG and smaller; stranded for No. 6 AWG and larger.
- C. Control Circuits: Copper. 16 AWG stranded for wiring inside the control panel, 14 AWG solid when routed to field mounted digital instruments.
- D. Analog Circuits: Copper. 100% shielded, 18 stranded gauge, twisted pairs or otherwise noted.

3.2. CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway
- C. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

3.3. INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. 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.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.4. 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.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5. IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "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.

3.6. SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7. FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.8. 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. 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.
 - 3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - 4. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 5. 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.
- B. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.

3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings of the Contract, including but not limited to the General and Special Conditions and Division 01 Special Provisions Sections, apply to this Section.

1.2. SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.3. ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4. QUALITY CONTROL

- 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. 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

2.1. CONDUCTORS

- A. Insulated Conductors: Copper or tinned-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. Grounding Conductor: No. 4/0 or No. 2 AWG, stranded conductor.
 - 5. Grounding Connectors: Cadweld or equivalent.

2.2. CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors 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.

2.3. GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

PART 3 – EXECUTION

3.1. APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. 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.

3.2. EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- 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. Flexible raceway runs.
 5. Busbar Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on bus bar.
 6. 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. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3. 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 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 and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
- C. 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. Make connections to building steel.
 - 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.

3.4. LABELING

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.

3.5. FIELD QUALITY CONTROL

- A. 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.
 - 4. 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.
 - 5. Perform tests by fall-of-potential method according to IEEE 81.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. 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 Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Airport Authority promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 260533 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings of the Contract, including but not limited to General and Special Conditions and Division 01 Special Provisions Sections, apply to this Section.

1.2. 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 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3. DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.
- C. PVC: Polyvinyl Chloride plastic conduit.

1.4. ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 – MATERIALS

2.1. METAL CONDUITS, TUBING, 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 or equal:
 1. AFC Cable Systems, Inc.
 2. Allied Tube & Conduit; a Tyco International Ltd. Co.

3. Anamet Electrical, Inc.
 4. Electri-Flex Company.
 5. O-Z/Gedney; a brand of EGS Electrical Group.
 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 7. Republic Conduit.
 8. Robroy Industries.
 9. Southwire Company.
 10. Thomas & Betts Corporation.
 11. Western Tube and Conduit Corporation.
 12. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal 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. 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 NEMA RN 1.
 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. FMC: Comply with UL 1; zinc-coated 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:
 - a. Material: Steel
 - b. Type: Setscrew or 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 (1 mm), with overlapping sleeves protecting threaded joints.
- K. 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.

2.2. NONMETALLIC CONDUITS, TUBING, 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 or equal:
1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.
 6. Condux International, Inc.
 7. Electri-Flex Company.
 8. Kraloy.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Niedax-Kleinhuis USA, Inc.
 11. RACO; a Hubbell company.
 12. 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. LFNC: Comply with UL 1660.
- F. Rigid HDPE: Comply with UL 651A.
- G. RTRC: Comply with UL 1684A and NEMA TC 14.
- H. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- I. Fittings for LFNC: Comply with UL 514B.
- J. 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).
- K. 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."

2.3. METAL WIREWAYS AND AUXILIARY GUTTERS

- 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 or equal:
1. Cooper B-Line, Inc.
 2. Hoffman; Pentair company.
 3. Mono-Systems, Inc.

4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 4 unless otherwise indicated, and sized according to NFPA 70.
- 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: Flanged-and-gasketed type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4. BOXES, ENCLOSURES, AND CABINETS

- 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 or equal:
 1. Adalet.
 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. FSR Inc.
 6. Hoffman; a Pentair company.
 7. Hubbell Incorporated; Killark Division.
 8. Kraloy.
 9. Milbank Manufacturing Co.
 10. Mono-Systems, Inc.
 11. O-Z/Gedney; a brand of EGS Electrical Group.
 12. RACO; a Hubbell Company.
 13. Robroy Industries.
 14. Spring City Electrical Manufacturing Company.
 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 16. Thomas & Betts Corporation.
 17. 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. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

- H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.¹
- I. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- J. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- K. Cabinets:
 - 1. NEMA 250, 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.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5. 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.
 - 3. Boxes shall be as shown in details on the plans.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 - 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 or equal:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation; Hubbell Power Systems.
 - d. NewBasis.
 - e. Oldcastle Precast, Inc.; Christy Concrete Products.
 - f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
 - g. Jensen
 - h. San Diego Precast
 - 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, "POWER" OR "COMM".
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 24 Inches Long (300 mm Wide by 600 mm Long)] and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 – EXECUTION

3.1. RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed Conduit: GRC
 2. Concealed Conduit, Aboveground: EMT
 3. Underground Conduit: Type SCH-40-PVC
 4. Retain first option in first subparagraph below if raceway may be exposed to physical damage.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
 6. 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.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250,
 8. Type 4 stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size above ground, 1-inch (25mm) below ground.
- 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 setscrew or 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.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C)

3.2. 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 (150 mm) 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 26 05 29 "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. First paragraph below is more restrictive than NFPA 70, which permits up to four quarter bends in a conduit run. Retain paragraph for more conservative design, with less stress being placed on conductors being pulled in.
- G. 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 (300 mm) of changes in direction.
- H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- J. Raceways Embedded in Slabs:
 1. Run conduit larger than 1-inch (27-mm) 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 (3-m) intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.
- K. 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.
- L. Retain "Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions" Paragraph below to require application of protective joint compound to threads of rigid steel conduit or IMC and to their fittings where these raceways are installed outdoors or in wet, damp, or corrosive conditions. This optional requirement exceeds NFPA 70 rules. If retaining, coordinate with Drawings indicating wet, damp, or corrosive indoor locations.
- M. 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.
- N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- O. Retain one of first two paragraphs below to exceed NFPA 70 requirements. NFPA 70 requires insulated bushings or other smooth, rounded entry provisions for conduit terminations at all locations where conductors are No. 4 AWG and larger, regardless of the environment. NFPA 70 requires bonding of all service conductors, but does not require bonding to be accomplished with grounding bushings. See Evaluations for further discussion.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. 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 (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. 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.
- T. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- V. Surface Raceways:
 1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.

2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) 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.
- W. 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.
- X. 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.
- Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Z. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) 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 (0.06 mm per meter of length of straight run per deg C) 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 (0.0115 mm per meter of length of straight run per deg C) 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.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

BB. 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 center of box unless otherwise indicated.

CC. 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.

DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

EE. Locate boxes so that cover or plate will not span different building finishes.

FF. 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.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

HH. Set metal floor boxes level and flush with finished floor surface.

II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3. 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 on the plans.
2. Install backfill.
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 (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
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.
6. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.

7. 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 (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
8. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4. 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.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) 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 (25 mm) above finished grade.
- D. 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.
- E. 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.

3.5. SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.6. FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.7. 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 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings of the Contract, including General and Special Conditions and Division 01 Special Provisions Sections, apply to this Section.

1.2. SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3. ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4. QUALITY CONTROL

- A. Comply with ANSI A13.1
- 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. Adhesive-attached labeling is not permitted.

1.5. COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 – PRODUCTS

2.1. POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
- C. Black letters on an orange field
- D. Legend: Indicate voltage
- E. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- F. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- G. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- H. Metal Tags: Brass or aluminum, 2" by 2" by 0.05" inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- I. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2. ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Colors for Cables Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field
 - 2. Legend: Indicate voltage
- C. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.
- E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

2.3. POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.
- C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- D. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.
- F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.4. CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

2.5. UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE, Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.6. WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs:
 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign 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 (915 MM)."

2.7. EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.8. CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.9. MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select 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.

PART 3 – EXECUTION

3.1. INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products are not permitted.
- E. Attach signs and plastic labels with stainless steel machine screws or similar fasteners appropriate to the location and substrate.
- F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall.
- K. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2. IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) 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.
- B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.
- C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Power.
 - 3. UPS.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded conductors.
 - a. Color shall be factory applied
 - b. Colors for 208/120-V Circuits:
 - (i) Phase A: Black.

- (ii) Phase B: Red.
 - (iii) Phase C: Blue.
- c. Colors for 480/277-V Circuits:
 - (i) Phase A: Brown.
 - (ii) Phase B: Orange.
 - (iii) Phase C: Yellow.
- d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive, self-laminating polyester labels with the conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- M. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- N. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Secure labels with stainless steel machine screws, not self-adhesive glue.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label. Secure labels with stainless steel machine screws, not self-adhesive glue.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure. Self-adhesive backing is not permitted.
 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

- g. Emergency system boxes and enclosures.
- h. Motor-control centers.
- i. Enclosed switches.
- j. Enclosed circuit breakers.
- k. Enclosed controllers.
- l. Push-button stations.
- m. Power transfer equipment.
- n. Contactors.
- o. Remote-controlled switches, dimmer modules, and control devices.
- p. Power-generating units.
- q. Monitoring and control equipment.

END OF SECTION

SECTION 260573.19 – ARC-FLASH HAZARD ANALYSIS

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3. 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.
- 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 Systems 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 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."

1.4. ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
 - 3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5. INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6. CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
2. 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.

1.7. QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. 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

COMPUTER SOFTWARE DEVELOPERS

2.1. SKM POWER TOOLS

- A. ETAP Electrical Calculation Software
- B. Approved Equal
- C. Comply with IEEE 1584 and NFPA 70E.
- D. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2. 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 260573.13 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "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:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. 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.

2.3. 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.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. 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.

PART 3 – EXECUTION

3.1. EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2. ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit study prior to starting the Arc-Flash Hazard Analysis or obtain results from another source.
 - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
 - 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "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 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
 - 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 B.1.2.

3.3. POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on one-line diagram on Drawings. Call discrepancies to Architect's attention.
 - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
 - 1. Product Data for overcurrent protective devices specified in other 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. Obtain electrical power utility impedance or available short circuit current at the service.
 - 3. Power sources and ties.
 - 4. Short-circuit current at each system bus (three phase and line to ground).
 - 5. Full-load current of all loads.
 - 6. Voltage level at each bus.
 - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
 - 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4. LABELING

- A. Apply one arc-flash label on the front cover of each section of the equipment for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
 1. Motor-control center.
 2. Low-voltage switchboard.
 3. Switchgear.
 4. Medium-voltage switch.
 5. Medium voltage transformers
 6. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
 7. Panelboard and safety switch over 250 V.
 8. Applicable panelboard and safety switch under 250 V.
 9. Screw Press Control panel.
- C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
 1. Indicate arc-flash energy.
 2. Indicate protection level required.

3.5. APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6. DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION

SECTION 262200 – LOW-VOLTAGE TRANSFORMERS

PART 1 – GENERAL

1.1. SUMMARY

A. Section Includes:

1. Requirements for the following types of dry-type transformers rated 600 Volts and less, with capacities up to 1000 kVA:
 - a. Distribution transformers.

B. Related Requirements:

1. Section 033000 - Cast-In-Place Concrete: Housekeeping pads.
2. Section 260526 - Grounding and Bonding for Electrical Systems.
3. Section 260529 - Hangers and Supports for Electrical Systems.
4. Section 260533 - Raceway and Boxes for Electrical Systems.
5. Section 260553 - Identification for Electrical Systems.

1.2. REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA ST 1 - Specialty Transformers (Except General Purpose Type).
2. NEMA ST 20 - Dry Type Transformers for General Applications.

1.3. SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: See Below.
- B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.
- C. Test and Evaluation Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
- D. Source Quality Control Submittals: Indicate results of factory tests and inspections.
- E. Field Quality Control Submittals: Indicate results of Contractor furnished tests and inspections.

1.4. CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Record Documentation: Record actual locations of transformers.

1.5. QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

1.6. CERTIFICATIONS

A. Electrical Listing and Labeling:

1. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - a. Provide products marked with their intended use or classification.
 - b. Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - (i) Such evidence may consist of either a printed mark on the data or a separate listing card.
2. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - a. Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner.

1.7. DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 – PRODUCTS

2.1. LOW-VOLTAGE TRANSFORMER EQUIPMENT

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Owner from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - (i) Obtain each transformer type from a single source from a single manufacturer.

B. Description:

1. Regulatory Requirements:
 - a. National Electrical Code (NEC):
 - (i) Provide products and installation complying with requirements specified for transformers in NFPA 70.
- C. Design Criteria:
 1. Transformers:
 - a. Provide factory-assembled and factory-tested, air-cooled transformer units designed for 60 Hertz service, and having a 3-phase, 4-wire primary, and a 3-phase, 4-wire secondary.
 - (i) Cores:
 - Provide grain-oriented, non-aging silicon steel transformer cores.
 - (ii) Coils:
 - Provide continuous copper coil windings without splices except for taps.
 - Provide brazed or pressure type internal coil connections.
 - b. Provide transformer units complying with the requirements specified in IEEE C57.12.91.
 2. Product Data:
 - a. Submit Product Data for each type and size of transformer to be provided under this Section to the Owner for approval.
 - (i) Include the rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
 3. Shop Drawings:
 - a. Submit Shop Drawings that detail the transformer equipment assemblies, and indicate the dimensions, weights, loads, required clearances, method of field assembly, components, and the location and size of each field connection to the Owner for approval.
 - (i) Wiring Diagrams:
 - Include power, signal, and control wiring diagrams.
- D. Materials:
 1. Distribution Transformers:
 - a. Provide distribution transformers complying with the requirements specified in NEMA ST 20, and listed and labeled in accordance with the requirements specified in UL 1561.
 - b. Cores:
 - (i) Provide transformer cores having 1 leg per phase.
 - c. Low-Sound-Level Requirements:

- (i) Provide a minimum low-sound-level of 3 dBA less than the standard sound levels specified in NEMA ST 20 when factory-tested in accordance with the methods specified in IEEE C57.12.91.
- d. Enclosure:
 - (i) Provide totally enclosed non-ventilated transformer enclosures complying with the requirements for NEMA Type 2 enclosures specified in NEMA 250.
 - (ii) Provide cores and coils encapsulated within a resin compound that, seals out both moisture and air.
- e. Transformer Enclosure Finish:
 - (i) Provide a gray transformer enclosure finish complying with the requirements specified in NEMA 250.
- f. Taps:
 - (i) For transformers rated 25 kVA and larger, provide two 2.5 percent taps above and two 2.5 percent taps below the normal full capacity.
- g. Insulation Class:
 - (i) Provide a UL-component-recognized insulation system rated for 220 degrees Celsius, with a maximum of 80 degrees Celsius rise above a 40 degrees Celsius ambient temperature.
- h. Energy Efficiency:
 - (i) For transformers rated 15 kVA and larger, provide units complying with the requirements for Class 1 efficiency levels specified in NEMA TP 1 when tested in accordance with the methods specified in NEMA TP 2.
- i. Wall Brackets:
 - (i) For transformers indicated to be wall-mounted on the Contract Drawings, provide the manufacturer's standard wall brackets.
- j. Manufacturers:
 - (i) ACME Electric Corporation, Power Distribution Products Division, www.acmepowerdist.com.
 - (ii) Controlled Power Company, www.controlledpwr.com.
 - (iii) Cutler-Hammer, Eaton Electrical Inc., www.eaton.com/EatonCom/Markets/Electrical/.
 - (iv) Federal Pacific Transformer Company, Division of Electro-Mechanical Corp., www.federalpacific.com
 - (v) Hammond Manufacturing Ltd., www.hammondmfg.com.
 - (vi) Magnetek, www.magnetek.com.

- (vii) Micron Industries Corp., www.microntransformers.com.
- (viii) Myers Power Products, Inc., <http://www.myerspwrproducts.com>.
- (ix) Sola/Hevi-Duty, www.solahevduty.com.
- (x) Square D; a brand of Schneider Electric, www.schneider-electric.us.
- (xi) Approved equal.

2.2. ACCESSORIES

A. Identification Devices:

1. Transformer Nameplates:

- a. For each transformer, provide laminated-plastic or metal engraved nameplates as specified in Section 260553, Identification for Electrical Systems, and mounted with corrosion-resistant screws.

2.3. SOURCE QUALITY CONTROL

A. Tests and Inspections:

- 1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Owner.

2. Sound-Level Test:

a. Test Procedure:

- (i) Have the Testing Agency factory-test the sound-level of the equipment provided for this Contract under this Section in accordance with the methods specified in IEEE C57.12.91.
- (ii) Have the Testing Agency prepare source quality-control Sound-Level Test Reports documenting the results of the testing, and submit them to the Owner for information.

b. Acceptance Criteria:

- (i) Equipment having a minimum low-sound-level of 3 dBA less than the standard sound levels specified in NEMA ST 20 passes the Sound-Level Test.

2.4. IEEE STANDARD TESTS:

A. Test Procedure:

- 1. Have the Testing Agency factory-test the transformers in accordance with the requirements specified in IEEE C57.12.91.
- 2. Have the Testing Agency prepare source quality-control IEEE Standard Test Reports documenting the results of the testing, and submit them to the Owner for information.

B. Acceptance Criteria:

- 1. Equipment complying with the requirements specified in IEEE C57.12.91 passes the IEEE Standard Tests

- C. Inspections:
 - 1. Have the Testing Agency inspect the transformers in accordance with the requirements specified in IEEE C57.12.91.
- D. Non-Conforming Work:
 - 1. Do not allow defective equipment to be shipped to the Site.
- E. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when transformers for this Contract are being fabricated and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 – EXECUTION

3.1. EXAMINATION

- A. Verification of Conditions:
 - 1. Examine conditions where the transformers will be installed for compliance with the enclosure- temperature and ambient-temperature requirements for each transformer.
 - 2. Verify by field measurements that the dimensions are as needed to maintain the working clearances required by NFPA 70 and manufacturer's written instructions.
 - 3. Examine walls, floors, roofs, and concrete bases where the transformers will be installed for suitable mounting conditions.
 - 4. Verify that the ground connections are in place, and that the requirements specified in Section 26 05 26, Electrical Grounding and Bonding, have been met.
 - a. The maximum allowable ground resistance at the location of a transformer is 5 ohms.
- B. Evaluation and Assessment:
 - 1. Proceed to install the transformers only after unsatisfactory conditions have been corrected.

3.2. PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements {01700 - Execution Requirements}: Requirements for installation preparation.
- B. Provide concrete pads under provisions of Section 03 30 00.

3.3. DEMOLITION

- A. Disconnect and remove abandoned transformers.
- B. Maintain access and adequate ventilation to existing transformers and other installations remaining active and requiring access and ventilation. Modify installation or provide access panel or ventilation grilles.

3.4. INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by the transformer manufacturer.
- B. Install and anchor floor-mounted transformers level and plumb on concrete bases.
- C. Systems Integration:
 - 1. Ground the transformer equipment in accordance with the requirements specified in Section 260526, Electrical Grounding and Bonding.
 - 2. Connect the transformer wiring in accordance with the requirements specified in Section 260519, Low Voltage Electrical Power Conductors and Cables.

3.5. SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when the transformers are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Owner to grant final acceptance of the Work.
 - 2. Testing Agency Responsibilities:
 - a. Have the Testing Agency employed by the Contractor perform the tests and inspections specified herein, and prepare a written Field Quality-Control Report for each test and inspection conducted to record the following information pertaining to the test or inspection:
 - (i) The transformers included in the testing.
 - (ii) Test procedures used to perform the testing.
 - (iii) Test results that comply with the requirements specified.
 - (iv) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - Note deficiencies detected, remedial action taken, and observations after remedial action.
- 3. NETA Acceptance Testing:

- a. Test Procedure:
 - (i) Have the Testing Agency perform each electrical test specified for transformers in ANSI/NETA ATS.
 - (ii) Have the Testing Agency prepare a certified NETA Acceptance Testing Field Quality-Control Report that identifies the transformers included and documents the NETA acceptance testing, and submit the Report to the Owner for information.
 - b. Acceptance Criteria:
 - (i) Have the Testing Agency submit certification of compliance with the test parameters specified in ANSI/NETA ATS to the Owner for approval.
 - (ii) Test Labeling:
 - On satisfactory completion of the testing of each unit, have the Testing Agency attach a dated and signed "Satisfactory Test" label to the tested unit.
4. Infrared Scanning:
- a. Test Procedure:
 - (i) Instruments and Equipment:
 - Have the Testing Agency furnish and use a portable infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - Have the Testing Agency submit a calibration record for the infrared scanning device to the Owner for information.
 - (ii) Initial Infrared Scanning:
 - Two months after Substantial Completion, have the Testing Agency perform an infrared scan of the transformer connections.
 - (iii) Follow-up Infrared Scanning:
 - Have the Testing Agency perform 2 additional follow-up infrared scans of each transformer, the first follow-up scan 4 months after the date of Substantial Completion, and the second follow-up scan 7 months after the first follow-up scan.
 - (iv) Have the Testing Agency prepare a certified Infrared Scanning Field Quality-Control Report that identifies the transformers included and describes the infrared scanning results, and submit the report to the Owner for information.
 - b. Acceptance Criteria:
 - (i) Significant deviations from normal temperature values are cause for the transformer under test to fail the infrared scanning testing.
 - (ii) Test Labeling:
 - On satisfactory completion of the testing of each unit, have the Testing

Agency attach a dated and signed "Satisfactory Test" label to the tested unit.

5. Inspections:

- a. Have the Testing Agency perform each visual and mechanical inspection and electrical test specified in ANSI/NETA ATS.

B. Non-Conforming Work

1. Remove and replace units that do not pass the tests or inspections, and retest the replacements as specified above.

C. Manufacturer Services:

1. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - a. Have the factory-authorized service representative perform tests and inspections, and prepare and submit certified test reports to the Owner for information.

3.6. ADJUSTING

- A. Record the transformer secondary voltage at each low-voltage transformer unit for at least 48 hours of a typical occupancy period.
 1. Adjust the transformer taps to provide the optimum voltage conditions at the secondary terminals.
 - a. Optimum is defined as not exceeding the nameplate voltage plus 10 percent, and not being lower than the nameplate voltage minus 3 percent, at maximum load conditions.
 2. Submit the recorded transformer secondary voltages and tap settings as test results to the Owner for information.
- B. Output Settings Report:
 1. Prepare a written Output Settings Report recording the output voltages and tap settings and submit the Report to the Owner for information.

3.7. CLEANING

- A. Clean the area around the transformers by vacuuming dirt and debris; do not use compressed air to assist in the cleaning.

END OF SECTION

SECTION 262416 – PANELBOARDS

PART 1 – GENERAL

1.1. SUMMARY

A. Section Includes:

1. Requirements for the following types of panelboards:
 - a. Distribution panelboards.
 - b. Lighting and appliance branch-circuit panelboards.
 - c. Electronic-grade panelboards.

B. Related Requirements:

1. Section 260526 - Grounding and Bonding for Electrical Systems.
2. Section 260553 - Identification for Electrical Systems.
3. Section 262813 - Fuses.
4. Section 013300 - Submittal Procedures.
5. Section 017000 - Closeout Submittals.
6. Section 033000 - Cast-in-Place Concrete.
7. Section 260573 - Overcurrent Protective Device Coordination.

1.2. REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers:

1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:

1. NEMA FU 1 - Low Voltage Cartridge Fuses.
2. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
3. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
4. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
5. NEMA PB 1 - Panelboards.
6. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories Inc.:

1. UL 50 - Cabinets and Boxes
2. UL 67 - Safety for Panelboards.
3. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
4. UL 1283 - Electromagnetic Interference Filters.
5. UL 1449 - Transient Voltage Surge Suppressors.
6. UL 1699 - Arc-Fault Circuit Interrupters.

F. Abbreviations and Acronyms:

1. AC: Alternating electric current.
2. AFCI: Arc-Fault Circuit-Interrupter.
3. GFCI: Ground Fault Circuit Interrupter.
4. GFEP: Ground Fault Equipment Protection.
5. HVAC: Heating Ventilating and Air Conditioning.
6. LED: Light emitting diodes.
7. MCCB: Molded-case circuit breakers.
8. NRTL: Nationally Recognized Testing Laboratory.
9. RMS: Root-mean-square.
10. SVR: Suppressed voltage rating.
11. TVSS: Transient voltage surge suppressor.

1.3. SUBMITTALS

A. Action Submittals:

1. Submit the following to the Owner for approval in accordance with the requirements of Section 01 33 00, Submittal Procedures:
 - a. Product Data:
 - (i) Distribution panelboards.
 - (ii) Lighting and appliance branch-circuit panelboards.
 - (iii) Load centers.
 - (iv) Electronic-grade panelboards.
 - (v) Molded-case circuit breakers (MCCB).
 - (vi) Fused switches.

- (vii) Surge protection devices.
 - (viii) Accessory set.
 - (ix) Portable test set.
 - b. Shop Drawings:
 - (i) Panelboards and related equipment.
 - (ii) Setting drawings, templates, diagrams, instructions, and directions for placing and securing anchorage devices.
 - (iii) Panelboard schedules.
 - c. Certificates:
 - (i) Electrical Listing and Labeling.
 - (ii) Seismic Qualification Certificates.
 - (iii) Certification of compliance with the inspection parameters specified in ANSI/NETA ATS.
 - d. Qualification Statements:
 - (i) Testing Agency's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Owner for information in accordance with the requirements of Section 01 33 00, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - (i) Manufacturer's installation, operation, and starting instructions for the panelboard equipment and systems.
 - b. Site Quality Control Submittals:
 - (i) Calibration record for the infrared scanning device.
 - (ii) Insulation Resistance Tests Field Quality-Control Report.
 - (iii) Electrical Continuity Tests Field Quality-Control Report.
 - (iv) NETA Acceptance Testing Field Quality-Control Report.
 - (v) Infrared Scanning Field Quality-Control Report.
- C. Closeout Submittals:
 - 1. Submit the following to the Owner in accordance with the requirements of Section 017700, Closeout Procedures:
 - a. Operation and Maintenance Data:
 - (i) Operation and maintenance data for the panelboards and components.

b. Warranty Documentation:

- (i) Panelboards Warranty.

D. Maintenance Material Submittals:

1. Submit the following to the Owner in accordance with the requirements of Section 017700, Closeout Procedures:

- a. Spare Parts: Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective covering for storage identified with labels describing the contents of the packages:

- (i) Keys: Furnish 2 spare keys for each type of panelboard cabinet lock.
- (ii) Circuit Breakers: Furnish 2 spare circuit breakers, including GFCI and Ground Fault Equipment Protection (GFEP) types, for each panelboard.
- (iii) Fuses for Fused Switches: Furnish a number of fuses for fused switches equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.
- (iv) Fuses for Fused Power-Circuit Devices: Furnish a number of fuses for fused power-circuit devices equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.

b. Tools:

- (i) Accessory set.
- (ii) Portable test set.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Owner to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the Owner, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the 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.
 - a. Maintain required workspace clearances and required clearances for equipment access doors and panels.
3. Coordinate the sizes and locations of concrete bases for freestanding panelboards with the actual equipment provided.

B. Sequencing:

1. For floor mounted panelboards, provide concrete bases and anchorage devices prior to installing the panelboards.

1.5. QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:

a. Code-Required Approved Agency for Performing Special Inspections:

- (i) To perform the special inspections required by the California Building Code, the Owner acting as the Owner's agent will employ an independent Approved Agency.

2. Testing and Inspection Agencies:

- a. To perform testing and inspections not considered special inspections by the California Building Code, the Owner will employ both an independent Testing and Inspection Agency.

B. Qualifications:

1. Testing Agency's Qualifications:

- a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - (i) Testing Agency's Field Supervisor: The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with ANSI/NETA ETT, or by the National Institute for Certification in Engineering Technologies (NICET).
 - (ii) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Owner for approval.

C. Certifications:

1. Electrical Listing and Labeling:

- a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - (i) Provide products marked with their intended use or classification.
 - (ii) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - Such evidence may consist of either a printed mark on the data or a separate listing card.

- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - (i) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

- 1. Receive, inspect, handle, and store panelboards in accordance with the requirements specified in NECA 407 or NEMA PB 1.1.

B. Storage and Handling Requirements:

- 1. Remove loose packing and flammable materials from the inside of the panelboards.
- 2. Handle and prepare panelboards for installation in accordance with the requirements specified in NECA 407 or NEMA PB 1.1.

1.7. SITE CONDITIONS

A. Ambient Conditions:

- 1. Do not deliver or install panelboards in spaces until the spaces are enclosed and weathertight, all wet work in the spaces is complete and dry, work above the panelboards is complete, and a temporary heating ventilating and air conditioning (HVAC) system is operating and maintaining the ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Existing Conditions:

1. Interruption of Existing Electric Service:

- a. Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electric service according to the requirements indicated:
 - (i) Notify the Owner no fewer than 2 days in advance of the proposed interruption of electric service.
 - (ii) Do not interrupt electric service without the Owner's written permission.

PART 2 – PRODUCTS

2.1. GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344.
- B. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Finishes:
 - a. Panels and Trim: Steel and 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.
 - b. Back Boxes: Same finish as panels and trim.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 - 7. 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.
 - 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 - 4. Split Bus: Vertical buses divided into individual vertical sections.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical.
 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, or Mechanical.
 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: NRTL 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 Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2. DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.
- 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. Branch Overcurrent Protective Devices: Fused switches.
- H. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 2. External Control-Power Source: 120-V branch circuit.

2.3. LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. External Control-Power Source: 120-V branch circuit.
- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4. DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity 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-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.

- c. Long- and short-time time adjustments.
- d. Ground-fault pickup level, time delay, and I 2t response.
- 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-
- 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- 6. Ground-Fault Equipment Protection (GFE) Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
- 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 "Electrical Power Monitoring and Control."
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - j. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.5. 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

3.1. 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.

3.2. INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Comply with mounting and anchoring requirements specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- D. Mount top of trim maximum of 90 inches above finished floor unless otherwise indicated.
- 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 recessed 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. Additional conduits will be as shown in plans.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

3.3. IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "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 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 26 05 53 "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 26 05 53 "Identification for Electrical Systems."

3.4. 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 Division 26 Section "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 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.

END OF SECTION

SECTION 264313 – SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SUMMARY

- A. Section includes:
 - 1. Type 1 surge protective devices.
 - 2. Type 2 surge protective devices.
 - 3. Enclosures.
 - 4. Conductors and cables.
- B. Related Requirements:
 - 1. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
 - 2. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
 - 3. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.3. DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: air of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. NRTL: Nationally recognized testing laboratory.
- F. OCPD: Overcurrent protective device.
- G. SCCR: Short-circuit current rating.
- H. SPD: Surge protective device.
- I. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- J. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
- K. Type 3 SPDs: Point of utilization SPDs.
- L. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.
- M. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.
- N. VPR: Voltage protection rating.

1.4. ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include electrical characteristics, specialties, and accessories for SPDs.
 - 2. NRTL certification of compliance with UL 1449.
 - a. Tested values for VPRs.
 - b. Inominal ratings.
 - c. MCOV, type designations.
 - d. OCPD requirements.
 - e. Manufacturer's model number.
 - f. System voltage.
 - g. Modes of protection.

1.5. INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.6. CLOSEOUT SUBMITTALS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7. WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship within five (5) years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1. TYPE 1 SURGE PROTECTIVE DEVICES (SPDS)

- A. ABB.
- B. Altec
- C. Approved Equal
- D. Source Limitations: Obtain devices from single source from single manufacturer.
- E. Standards:
 - 1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- F. Product Options:
 - 1. Include integral disconnect switch.
 - 2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 3. Include indicator light display for protection status.
 - 4. Include audible alarm.
 - 5. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V ac for remote monitoring of protection status.

6. Include surge counter.

G. Performance Criteria:

1. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 160 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - b. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
4. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
 - a. Line to Neutral: 700 V.
 - b. Line to Line: 1200 V.
5. SCCR: Not less than 100 kA.
6. Inominal Rating: 20 kA.

2.2. TYPE 2 SURGE PROTECTIVE DEVICES (SPDS)

- A. ABB.
- B. Altec
- C. Approved Equal
- D. Source Limitations: Obtain devices from single source from single manufacturer.
- E. Standards:
 1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.
 2. Comply with UL 1283.
- F. Product Options:
 1. Include LED indicator lights for power and protection status.
 2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 Vac for remote monitoring of protection status.
 4. Include surge counter.
- G. Performance Criteria:
 1. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.

2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
 3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - b. Line to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - c. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - d. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
 4. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
 - a. Line to Neutral: 700 V.
 - b. Line to Ground: 700 V.
 - c. Neutral to Ground: 700 V.
 - d. Line to Line: 1200 V.
 5. SCCR: Equal or exceed 100 kA.
 6. Inominal Rating: 10 kA.
- 2.3. TYPE 3, TYPE 4, AND TYPE 5 SURGE PROTECTIVE DEVICES (SPDS)
- A. Type 3, Type 4, and Type 5 SPDs are not approved for field installation.
- 2.4. ENCLOSURES
- A. Indoor Enclosures: NEMA 250, Type 1.
 - B. Outdoor Enclosures: NEMA 250, Type 4X.
- 2.5. CONDUCTORS AND CABLES
- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 – EXECUTION

3.1. INSTALLATION

- A. Comply with NECA 1.
- B. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's written instructions.
- C. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's written instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
 2. Do not exceed manufacturer's recommended lead length.
 3. Do not bond neutral and ground.

- D. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2. 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 the Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. SPDs that do not pass tests and inspections will be considered defective.
- C. Prepare test and inspection reports.

3.3. STARTUP SERVICE

- A. Complete startup checks in accordance with 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; reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4. DEMONSTRATION

- A. Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

SECTION 265600 – EXTERIOR LIGHTING

PART 1 – GENERAL

1.1. SUMMARY

- A. Section includes exterior luminaires, poles, and accessories.

1.2. REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C82.16-2015 – Light Emitting Diode Drivers
 - 2. ANSI O5.1 – Wood Poles, Specifications and Dimensions.

1.3. SUBMITTALS

- A. Shop Drawings: Indicate dimensions and components for each luminaire not standard Product of manufacturer.
- B. Product Data: Submit dimensions, ratings, and performance data.

1.4. QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

1.5. DELIVERY, STORAGE, AND HANDLING

- A. Store and handle solid wood poles in accordance with ANSI O5.1.

1.6. COORDINATION

- A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.7. MAINTENANCE MATERIALS

- A. Furnish two of each lamp installed.
- B. Furnish two ballasts of each lamp type installed.

PART 2 – PRODUCTS

2.1. LUMINAIRES

- A. Product Description: Complete exterior luminaire assemblies, with features, options, and accessories as scheduled.

2.2. LED FIXTURES

- A. Manufacturers:
 - 1. Cooper Industries Inc.
 - 2. General Electric Co.
 - 3. Substitutions: Permitted.

- B. Minimum Efficacy: 100 lumens/W, except where otherwise indicated or permitted by applicable code.

2.3. METAL POLES

A. Manufacturers:

1. HAPCO
2. LightMart
3. Ameron Poles
4. Substitutions: Permitted.

B. Material and Finish: Steel with prime finish for field painting.

C. Section Shape and Dimensions: Round, Tapered round, or Square.

D. Height As indicated on Drawings.

E. Base: Non-breakaway

F. Accessories:

1. Handhole.
2. Anchor bolts.

G. Loading Capacity Ratings:

1. Luminaire Weight: 25 pounds.
2. Luminaire and Bracket Effective Projected Area: 6 square feet.
3. Steady Wind: 50 miles per hour, minimum.

PART 3 – EXECUTION

3.1. EXAMINATION

- A. Verify foundations are ready to receive fixtures.

3.2. EXISTING WORK

- A. Disconnect and remove abandoned exterior luminaries.
- B. Extend existing exterior luminaire installations using materials and methods compatible with existing installations.
- C. Clean and repair existing exterior luminaries to remain or to be reinstalled.

3.3. INSTALLATION

- A. Install concrete bases for lighting poles at locations as indicated on Drawings, in accordance with Section 033000.
- B. Install poles plumb. Install shims or double nuts to adjust plumb. Grout around each base.
- C. Install lamps in each luminaire.
- D. Bond and ground luminaries, metal accessories and metal poles in accordance with Section 260526. Install supplementary grounding electrode at each pole per drawings.

3.4. FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

- B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

3.5. ADJUSTING

- A. Section 017000 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings.

3.6. CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Final cleaning.
- B. Clean photometric control surfaces as recommended by manufacturer.
- C. Clean finishes and touch up damage.

3.7. PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution and Closeout: Protecting finished work.
- B. Replace luminaries having failed LEDs at Substantial Completion.

3.8. SCHEDULES

- A. See drawings for fixture schedules and placement.

END OF SECTION

SECTION 312300 – EXCAVATION AND FILL

PART 1 – GENERAL

1.1. SUMMARY

A. Section Includes

1. Furnish all labor, materials, equipment, and incidentals necessary to perform all trenching for pipelines and appurtenances, including drainage, bedding, filling, backfilling, disposal of surplus material, and restoration of trench surfaces and easements.

B. Related Specification Sections include but are not necessarily limited to

1. Drawings and general provisions of the Contract, including Special Provisions, apply to work of this section.
2. Division 1 – General Requirements

1.2. REFERENCES

1. Reference standards cited in this specification refer to the current reference standard published at the time of the latest revision date logged at the end of this specification, unless a date is specifically cited.
- B. All excavation, trenching, and related sheeting, bracing, etc., shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P)
- C. Wherever compaction requirements are referred to herein it shall refer to Standard Proctor Density as determined by ASTM D 698.

1.3. ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4. SUBMITTALS

- A. Submittals shall be in accordance with Section 013323.
- B. All submittals shall be approved by the ENGINEER or the OWNER prior to delivery.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

- A. Prior to the start of work the CONTRACTOR is required to submit his/her proposed method of backfilling and compaction to the ENGINEER for review.
- B. If soil boring logs indicate the presence of groundwater within the proposed trench area, a Groundwater Dewatering Plan shall be submitted outlining how groundwater will be removed.
1. Groundwater Dewatering Plan shall be performed by and sealed by a licensed engineer in the State of California
 2. CONTRACTOR shall assume all responsibility for the adequacy of the methods, materials, and equipment employed.
- C. Embedment Compaction Plan

- 1.6. CLOSEOUT SUBMITTALS [NOT USED]
- 1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
- 1.8. QUALITY ASSURANCE [NOT USED]
- 1.9. DELIVERY, STORAGE, AND HANDLING [NOT USED]
- 1.10. FIELD CONDITIONS [NOT USED]
- 1.11. WARRANTY [NOT USED]

PART 2 – PRODUCTS [NOT USED]

PART 3 – EXECUTION

3.1. TRENCH EXCAVATION

- A. Trench excavation shall include material of every description and of whatever substances encountered, regardless of the methods or equipment required to remove the material. Pavement shall be cut with a saw, wheel or pneumatic chisel along straight lines before excavating.
 - 1. All excavation shall be made in open trenches.
 - 2. The length of open trench shall be related closely to the rate of pipe laying.
 - 3. Remove from the excavation all materials which the ENGINEER may deem unsuitable for backfilling.
- B. The CONTRACTOR shall strip and stockpile topsoil from grassed areas crossed by trenches. At the CONTRACTOR's option, topsoil may be otherwise disposed of and replaced, when required, with approved topsoil of equal quality.
- C. While excavating and backfilling is in progress, traffic shall be maintained, and all utilities and other property protected as provided in the Agreement.
- D. Trenches shall be excavated to the depth indicated on the Drawings and in widths sufficient for laying the pipe, bracing and for pumping and drainage facilities. The bottom of the excavations shall be firm and dry and, in all respects, acceptable to the ENGINEER. Trench width shall be practical minimum, but not less than 12-inches nor more than indicated on the Drawings.
 - 1. If conditions warrant, the CONTRACTOR may be ordered to deposit gravel for pipe bedding, or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever.

- E. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The trench may be excavated by machinery to, or just below, the designated subgrade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by gravel fill as required by the ENGINEER at the CONTRACTOR's expense.
- F. Clay and organic silt soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, the CONTRACTOR shall use smooth-edge bucket to excavate the last one foot of depth.
- G. Where pipe is to be laid in gravel bedding, the trench may be excavated by machinery to the normal depth of the trench provided that the material remaining in the bottom of the trench is no more than slightly disturbed.

3.2. SHEETING AND BRACING

- A. Furnish, put in place and maintain sheeting and bracing required by Federal, State or local safety requirements to support the sides of the excavation and prevent loss of ground which could endanger personnel, damage or delay the work, or endanger adjacent structures. If the ENGINEER is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports placed at the expense of the CONTRACTOR. Compliance with such order shall not relieve the CONTRACTOR from his responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.
- B. Where sheeting and bracing is required to support the sides of trenches, the CONTRACTOR shall engage a Professional ENGINEER, licensed in the State of California, to design the sheeting and bracing. The sheeting and bracing installed shall be in conformity with the design and certification of this shall be provided by the Professional ENGINEER.
- C. When moveable trench bracing such as trench boxes, moveable sheeting, shoring, or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the gravel backfill.
 - 1. When installing rigid pipe (R.C., D.I., V.C., etc.), any portion of the box extending below mid diameter shall be raised above this point prior to moving the box ahead to install the next pipe. This is to prevent the separation of installed pipe joints due to movement of the box.
 - 2. When installing flexible pipe (Steel, PVC, etc.) trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring, or plates are moved, gravel backfill shall be placed to fill any voids created and the gravel backfill shall be recompacted to provide uniform side support for the pipe.
- D. The CONTRACTOR will be permitted to use steel sheeting in lieu of wood sheeting for the entire job wherever the use of sheeting is necessary. The cost for use of sheeting shall be included in the bid items for trench safety and shall include full compensation for driving, bracing and later removal of sheeting.

- E. All sheeting and bracing shall be carefully removed in such manner as not to endanger the construction of other structures, utilities, or property, whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with gravel backfill by ramming with tools especially adapted to that purpose, or otherwise as directed.

3.3. TEST PITS

- A. The CONTRACTOR may be required to excavate test pits for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.
- B. Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as specified.

3.4. DRAINAGE AND DEWATERING

- A. The CONTRACTOR shall furnish all materials and equipment and perform all incidental work required to install and maintain the drainage system he proposes for handling groundwater or surface water encountered.
- B. The CONTRACTOR shall provide pumping equipment and devices to properly remove and dispose of all water entering trenches and excavations.
 - 1. The subgrade shall be maintained acceptably dry, to a level of 5 feet below the bottom of the trench, until the facilities to be built therein are completed.
 - 2. Piezometers shall be provided at appropriate locations for verification of dewatering depth.
 - 3. All drainage related work shall be performed without damage to the trench, pavement, pipes, electrical conduits, or other utilities and without damage to public or private property.
- C. The pipe or concrete shall not be laid in water or submerged within 24 hours after being placed. Water shall not flow over new concrete within four days after placement, or as designated on the plans.
- D. In no event shall water rise to cause unbalanced pressure on facilities until the concrete or mortar has set at least 24 hours. The CONTRACTOR shall prevent flotation of the pipe by promptly placing backfill.

3.5. EXCAVATION BELOW GRADE AND REFILL

- A. Whatever the nature of unstable material encountered or the groundwater conditions, trench drainage shall be complete and effective.
- B. If the CONTRACTOR excavates below grade through error or for his own convenience, or through failure to properly dewater the trench, or disturbs the subgrade before dewatering is sufficiently complete, he may be directed by the ENGINEER to excavate below grade as set forth in the following paragraph, in which case the work of excavating below grade and furnishing and placing the refill shall be performed at his own expense.

- C. If the material at the level of trench bottom consists of fine sand, sand and silt or soft earth which may work into the gravel backfill notwithstanding effective drainage, the subgrade material shall be removed to the extent directed and the excavation refilled with a 6-inch to 12-inch layer of crushed stone No. 67, or as approved by the ENGINEER, to form a filter layer preserving the voids in the gravel bed of the pipe.
 - 1. The composition and gradation of gravel shall be approved by the ENGINEER prior to placement.
 - 2. Gravel backfill shall then be placed in 6-inch layers, thoroughly compacted, up to the level indicated in the Drawings.
- D. Trench Geotextile Fabric may be installed in specified locations.
 - 1. Soils other than ML or OH in accordance with ASTM D2487
 - a. Needle punch, nonwoven geotextile composed of polypropylene fibers
 - b. Fibers shall retain their relative position
 - c. Inert to biological degradation
 - d. Resist naturally occurring chemicals
 - e. UV Resistant
 - f. Mirafi 140N by Tencate, or approved equal
 - 2. Soils Classified as ML or OH in accordance with ASTM D2487
 - a. High-tenacity monofilament polypropylene woven yarn
 - b. Percent open area of 8 percent to 10 percent
 - c. Fibers shall retain their relative position
 - d. Inert to biological degradation
 - e. Resist naturally occurring chemicals
 - f. UV Resistant
 - g. Mirafi FW402 by Tencate, or approved equal

3.6. EMBEDMENT

- A. Embedment for wastewater lines shall be as shown on the Drawings.
- B. The initial layer of embedment placed to receive the pipe shall be brought to the grade and dimensions indicated on the Drawings, and the pipe shall be placed thereon and brought to grade by tamping, or by removal of the slight excess amount of embedment under the pipe. Adjustments to grade shall be made by scraping away or filling with embedment material.
- C. Wedging or blocking up of pipe will not be permitted.
- D. Each pipe section shall have a uniform bearing on the embedment for the full length of the pipe, except immediately at the joint.
- E. All embedment shall extend the full width of the trench bottom.
- F. Embedment shall remain dewatered until all backfilling is complete.
- G. After the pipe has been laid, jointed, and inspected, embedment material shall be brought up in mechanically tamped layers not exceeding eight inches in thickness of loose fill, approximately equal on each side of the pipe, to 6 inches above the top of pipe.

- H. Embedment shall be compacted to minimum 90% relative density in accordance with ASTM D4253 and D5254.
 - 1. CONTRACTOR shall submit an Embedment Compaction Plan to the ENGINEER for approval prior to pipe laying activities. CONTRACTOR shall retain an independent geotechnical engineer to help prepare the compaction plan. Plan shall detail the method by which the embedment will be compacted including but not limited to the following:
 - a. Equipment Used
 - b. Compaction Process and Anticipated Passes
 - c. Lift Heights
 - d. Testing Procedure/Firm
 - 2. CONTRACTOR shall be required to retain an independent geotechnical engineering firm to visually inspect the pipe embedment compaction during construction and provide a certification that the embedment meets the compaction specifications stated above.
 - a. Geotechnical firm shall be subject to approval by the OWNER.
 - (i) CONTRACTOR shall retain the same firm to help prepare the compaction plan and to visually inspect compaction during construction.
 - b. A qualified representative shall be on-site at a minimum once during pipe laying. Representative shall be on-site for a long enough duration each day to observe and certify the embedment placing process.
 - c. At a minimum, qualified representative shall:
 - (i) Confirm lift thickness
 - (ii) Count number of passes
 - (iii) Confirm proper equipment is being used
 - (iv) Confirm aggregate weight

3.7. BACKFILLING

- A. As soon as practical after the initial bedding has been placed and the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. Embedment, as specified for the type of pipe installed, shall be placed as shown on the Drawings and as specified above.
- B. The remainder of the trench shall be filled per Embedment Details in the Drawings. Layers shall not exceed 6-inches in loose measure compacted to 90% of maximum density in accordance with ASTM D698. The backfill shall be mounded twelve (12) inches above the existing grade, or as directed.
- C. Where a grass, loam or gravel surface exists prior to excavation, it shall be removed, conserved, and replaced to the full original depth as part of the work under the pipe items. In some areas it may be necessary to remove excess material during the clean-up process, so that the ground may be restored to its original level and condition.

- D. To prevent longitudinal movement of the pipe, dumping backfill material into the trench and then spreading will not be permitted until the bedding material has been placed and compacted to a level 1-ft over the pipe.
- E. Backfill shall be brought up evenly on both sides of the pipe. Each layer of backfill material shall be thoroughly compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to fill throughout the full width of the trench.
- F. Compaction shall be by use of hand or pneumatic tamping with tools weighing at least 20 lbs. If necessary, sprinkling shall be employed in conjunction with rolling or ramming.
- G. Subject to the approval of the ENGINEER, fragments of ledge and boulders smaller than 4-in may be used in trench backfill providing that the quantity, in the opinion of the ENGINEER, is not excessive. Rock fragments shall not be placed until the pipe has at least 2-ft of cover. Small stones and rocks shall be placed in thin layers alternating with earth to ensure that all voids are completely filled. Fill shall not be dropped into the trench in a manner to endanger the pipe. If rock fragments are placed in the backfill material, it will be the CONTRACTOR's responsibility to prove to the ENGINEER that the specified compaction is occurring. If the ENGINEER's opinion is that the compaction is not achieved, then the CONTRACTOR shall remove material that contains rock fragments and replace it with suitable material.
- H. Bituminous paving shall not be placed in backfill unless specifically permitted, in which case it shall be broken up as directed. Frozen material shall not be used under any circumstances.
- I. Water jetting will not be accepted as a means of consolidating/compacting backfill.
- J. Dewatering shall be maintained until backfill is complete.

3.8. RESTORING TRENCH SURFACE

- A. Where the trench occurs adjacent to paved areas, road shoulders, sidewalks, or in cross-country areas, the CONTRACTOR shall thoroughly consolidate the backfill and shall maintain the surface as the work progresses. If settlement takes place, he shall immediately deposit additional backfill to restore the level of the ground.
- B. In paved areas, the edge of the existing pavement to be removed shall be cut along straight lines, and the pavement replaced as indicated on the Drawings.
- C. The surface of any driveway, or any other area, which is disturbed by the trench excavation and which is not a part of the paved road shall be restored by the CONTRACTOR to a condition at least equal to that existing before work began.
- D. In sections where the pipeline passes through grassed areas, the CONTRACTOR shall, at his own expense, remove and replace the sod, or shall loam and reseed the surface to the satisfaction of the ENGINEER.
- E. All road surfaces shall be broomed and hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

END OF SECTION

SECTION 315000 – EXCAVATION SUPPORT AND PROTECTION

PART 1 – GENERAL

1.1. SUMMARY

A. Section Includes:

1. Furnish all labor, materials, and equipment and perform all operations to plan, design, construct, install, maintain, monitor, modify as necessary, and remove upon completion, an Excavation Safety and Support System as specified herein.
2. The requirements of this Section apply to all trenches which equal or exceed a depth of five (5) feet, measured from the ground surface at the highest side of the trench to the trench bottom.
3. All applicable and non-conflicting portions of Section 312300, Excavation and Fill apply as appropriate.

B. Related Specification Sections include but are not necessarily limited to

1. General Provisions in Section D
 - a. GP 10.2.4 – Notice and Compliance with Applicable Law
 - b. GP 10.2.6 – Excavation
2. Division 1 - General Requirements.
3. Section 02221 – Trenching, Backfilling and Compaction.

1.2. REFERENCES

A. Reference Standards

1. Reference standards cited in this specification refer to the current reference standard published at the time of the latest revision date logged at the end of this specification, unless a date is specifically cited.
2. U.S. Occupational Safety and Health Administration (OSHA) Standards, 29 CFR 1926, Subpart P – Excavations, latest revision at time of construction Agreement execution.

1.3. ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4. SUBMITTALS

- A. Submittals shall be in accordance with Section 013323.
- B. All submittals shall be approved by the ENGINEER or the OWNER prior to delivery.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

- A. A site-specific excavation safety plan prepared by the CONTRACTOR. Such a plan shall cover how the CONTRACTOR intends to implement the plan in the field.
- B. A signed certification from the Excavation Safety Design Engineer declaring that his plan has been prepared in accordance with current O.S.H.A. Regulations and State of California Excavation Safety Laws.

- C. A signed statement from the CONTRACTOR declaring that he accepts and will follow the submitted safety plan.
- D. A signed statement from the CONTRACTOR acknowledging he is totally responsible for the safety of all persons involved in the construction of this project.
- E. A waiver claim for delay and time.

1.6. CLOSEOUT SUBMITTALS [NOT USED]

1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8. QUALITY ASSURANCE [NOT USED]

1.9. DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10. FIELD CONDITIONS [NOT USED]

1.11. WARRANTY [NOT USED]

PART 2 – PRODUCTS

2.1. GENERAL

- A. All materials and products incorporated into the Excavation Safety and Support System shall be suitable for their intended uses; shall meet all design criteria and parameters used by the System designer; and shall meet all applicable requirements of OSHA Standards.

PART 3 – EXECUTION

3.1. PROCEDURES

- A. After award of the contract by the County and prior to execution of the contract by the OWNER, CONTRACTOR shall submit a site-specific Excavation Safety and Support System Conformance Affidavit stating that operations will be conducted in full conformance with the OSHA Standards.
 - 1. The Conformance Letter shall also describe the Excavation Safety and Support System techniques proposed to be used on the project.
 - 2. Specific references to the applicable OSHA Standards sections shall be included for each technique to be used.
- B. The Excavation Safety and Support System Plan shall be in writing, site specific and sufficiently detailed and clear to be understandable and usable by all personnel who will be executing, supervising and witnessing the trenching operations. A copy of the plan shall be available at the site of trenching operations at all times. A second copy shall be provided to the ENGINEER for the OWNER's records.
- C. If borings and/or detailed geotechnical analyses are required to develop the Excavation Safety and Support System Plan, they shall be executed by the CONTRACTOR at his cost.
- D. A site-specific protective system shall be designed by a Licensed Professional Engineer experienced in soil mechanics and structural design. The design shall be signed, sealed and dated by the Professional Engineer, and it shall identify those specific locations where the design is applicable.

3.2. METHODS OF PROVIDING FOR EXCAVATION SAFETY AND SUPPORT SYSTEM

- A. Protective systems referenced in this Section shall be as defined and described in 29 CFR 1962.652, "Requirements for Protective Systems."
- B. It is the duty, responsibility and prerogative of the CONTRACTOR to determine the specific applicability of a proposed Excavation Safety and Support System for each field condition encountered on the project. CONTRACTOR specifically holds the OWNER, ENGINEER, and any of their designated representatives harmless in any actions resulting from the failure or inadequacy of the Trench Safety System used to complete the project.
- C. Unless otherwise noted on the drawings or excluded below, Sloping/Benching, Trench Shielding with trench boxes, and/or Sheet piling/Shoring/Bracing protective systems may be used on this project.
- D. Restrictions on the use of the various protective systems for this project are as follows:
 - 1. Sloping or Benchng. No Restrictions, except as noted on plans.
 - 2. Trench Shields/Boxes. No Restrictions.
 - 3. Sheet piling/Shoring/Bracing. No Restrictions.

3.3. INSPECTION DUTIES OF CONTRACTOR

- A. Provide a Competent Person, as defined in the OSHA Standards, to make frequent inspections of the trenching operations and the Excavation Safety and Support System in full conformance with the OSHA Standards.
- B. If evidence of a possible cave-in or landslide is apparent, all work in the trench shall immediately cease and not be resumed until all necessary precautions have been taken to safeguard personnel entering the trench.
- C. In an emergency situation which may threaten or affect the safety or welfare of any persons or properties, the CONTRACTOR shall act at his discretion to prevent possible damage, injury or loss. Any additional compensation or time extension claimed for such actions shall be considered in view of the cause of the emergency and in accordance with the Agreement.

END OF SECTION

SECTION 330563 – CONCRETE VAULTS AND CHAMBERS

PART 1 – GENERAL

1.1. SUMMARY

A. Section Includes

1. Furnish labor, materials, equipment, and incidentals necessary to procure, deliver, install and commission a Pressure Reducing Station (PRV Vault) generally confirming the requirements of SBCSD Standard Detail H-10B.
2. Extent of PRV Vault work required by this Section is indicated on Drawings and Schedules and by requirements of this Section.
3. Under this Section the CONTRACTOR shall furnish and install two (2) PRV Vault complete with 4-in main and 3-in bypass pressure reducing valves, pressure relief drain assembly, air vent assembly, lockable double roof access hatch with fall protection devices, isolation valves, magnetic flow meter, integral precast concrete valve vault structure, piping with required supports and fittings, vault access ladder with safety post extension, and other required appurtenances.
4. The PRV Vault MAY be manufactured and preassembled off site to ensure product quality and consistency. If so procured, the PRV Vault manufacturer or distributor shall provide sole-source responsibility to the OWNER through the warranty period for all equipment, piping and ancillaries associated with the PRV Vault.

B. Related Specification Sections include but are not necessarily limited to

1. General Provisions in Section D.
2. Division 1 – General Requirements.

1.2. REFERENCES

A. Reference Standards

1. Reference standards cited in this specification refer to the current reference standard published at the time of the latest revision date logged at the end of this specification, unless a date is specifically cited.
2. American Society for Testing and Materials (ASTM):
 - a. ASTM A 48 – Gray Iron Castings
 - b. ASTM C 150 - Portland Cement
 - c. ASTM C 443 – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
 - d. ASTM C 478 – Precast Reinforced Concrete Manhole Sections
 - e. ASTM C 88-86 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
 - f. ASTM C 330 - Specification for Lightweight Aggregates for Structural Concrete

- g. ASTM A 615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- h. ASTM A 706 - Specifications for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
- i. ASTM C 923 – Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes
- 3. American Association of State Highway Officials (AASHTO)
 - a. Standard Specifications for Highway Bridges

1.3. ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4. SUBMITTALS

- A. Submittals shall be in accordance with Section 013323.
- B. All submittals shall be approved by the ENGINEER or the OWNER prior to delivery and/or fabrication for specials.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data

- 1. PRV's
- 2. Isolation Valves
- 3. Flow Meter
- 4. Precast Vault

B. Drawings

- 1. Submit manufacturer's assembly-type shop drawings indicating dimensions, mechanical & electrical components, complete bill of materials, structural layout & reinforcing per calculations and structural weights. Structural reinforcing drawings shall be stamped by a Professional Engineer registered in the State the project is being installed.
- 2. The drawings for precast concrete units shall be furnished by the precast concrete producer for approval. These drawings shall show the design loads and standards have been met. Installation and construction information shall be included on shop drawings upon request.
- 3. For custom made precast concrete units, in addition to the requirements in B.1, the drawing for submittal shall show locations and dimensions to all penetrations and special embed items.

C. Precast Concrete Unit Data

- 1. Anchorage, Lifting Inserts and Devices
 - a. For anchors, lifting inserts and other devices, the precast concrete producer shall provide product data sheets and proper installation instructions upon request.
- 2. Accessory Items

- a. For items including, but not limited to sealants, gaskets, pipe entry connectors, steps, racks, and other items installed before or after delivery, include proper installation instructions and relevant product data.

D. Design Data

1. The manufacturer supply submittals showing design loading and material specifications for supplied products. At a minimum, the following shall be shown on the submittals:
 - a. Live load used in design
 - b. Vertical and lateral earth loads used in design
 - c. Depth of soil fill on the structure
 - d. Water table depth used in calculations
2. Precast concrete producer shall supply precast concrete unit design calculations and concrete mix design proportions and appropriate mix design test data. Structural design calculations shall be sealed by a licensed professional engineer in the state of this project.

E. Test Reports

1. Upon request, the precast concrete producer shall supply copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for Portland cement, blended cement, pozzolans, ground granulated blast-furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project
2. Upon request, the precast concrete producer shall submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the project conditions. Such tests may include compressive strength, plastic air content, temperature of freshly mixed concrete, and slump of freshly mixed concrete. Special tests for precast concrete items shall be clearly detailed in the specifications
3. Upon request, the precast concrete producer shall supply copies of in-plant QA/QC inspection reports.

1.6. CLOSEOUT SUBMITTALS [NOT USED]

1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8. QUALITY ASSURANCE

- A. To ensure that all equipment required for the installation of the PRV Vault is properly coordinated and will function as a unit in accordance with the intent of these specifications, the CONTRACTOR shall obtain all the equipment specified under this section, from a single supplier with whom the responsibility for the proper function of all equipment, regardless of manufacturer, as an integrated and coordinated system shall be vested. This requirement is to establish unit responsibility for all the equipment with the equipment supplier. The use of the word responsibility relating to the equipment supplier is in no way intended to relieve the CONTRACTOR's ultimate responsibility for equipment coordination, installation, operation, and guarantee.

- B. Factory pre-assembly: If a pre-assembled unit is proposed, during fabrication and before shipment, all equipment shall be fully factory installed to verify all proper clearances. All installed equipment, unless crossing structural joints, shall remain in the precast structure during travel to the jobsite and final re- assembly.

1.9. DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

1. Ship precast concrete products to the site, unload and handle in a manner to prevent damage.
2. Promptly remove any unit which is damaged from the construction site and replace with an undamaged unit.

1.10. FIELD CONDITIONS [NOT USED]

1.11. WARRANTY [NOT USED]

PART 2 – PRODUCTS

2.1. GENERAL

- A. All equipment, piping and appurtenances shall conform to the requirements of the STANDARDS FOR DOMESTIC WATER SYSTEMS - SPECIAL DISTRICTS DEPARTMENT, COUNTY OF SAN BERNARDINO, CALIFORNIA
 1. See Drawing H-10B
 2. Adapt dimensions for 4-in main and 3-in bypass pressure reducing valve
 3. Adjust piping arrangement for the main downstream isolation valve and pressure gauge tap to accommodate supply tap to chlorinator.
- B. Include magnetic flow meter downstream of the downstream bypass connection as shown in the drawings.

2.2. PREASSEMBLED PRECAST CONCRETE PRV VAULTS

A. Vault Manufacturers

1. Precast concrete vaults meeting the requirements of the specifications as manufactured by the following companies:
 - a. Oldcastle Precast
 - b. Jensen Precast
 - c. or OWNER pre-approved equal

2.3. PRESSURE REDUCING VALVES

A. CLA VAL

1. OWNER Pre-approved equal

2.4. FLOW METER

- A. McCrometer Ultra-Mag UM06.

- B. Siemens SITRANS F 5100W.
- C. Endress+Hauser Promag 53.
- D. Rosemount 8700.
- E. ABB WaterMaster.
- F. Or OWNER Pre-Approved Equal.

PART 3 – EXECUTION

3.1. PREPARATION

- A. The CONTRACTOR shall prepare and be responsible for any excavation in accordance with those shown on manufacturer's specification drawings.
- B. Prior to placing the precast structure into the excavation, the CONTRACTOR shall provide manhole base at the bottom of the excavation.
 - 1. Concrete manhole base, 12-inches minimum, shall be provided unless shown otherwise in plans.
 - 2. Base shall have #4 bars at 12" on center, each way, top and bottom unless otherwise shown in plans.
 - 3. The concrete base material shall be set at the proper elevation in conjunction with the conduit and the conduit entrance of vaults/manholes as designated on the plans.

3.2. ERECTION/INSTALLATION/APPLICATION

- A. Precast Concrete Manholes
 - 1. The manhole riser shall be set in a vertical, plumb position.
 - 2. All joints shall be sealed with mortar or an approved non-shrink grout on the inside and the outside of the manhole.
 - 3. Grade rings shall be mortared to each other on the inside and outside to provide a waterproof seal.

END OF SECTION

SECTION 338263 – SHELTER EQUIPMENT

PART 1 – GENERAL

1.1. SECTION INCLUDES

- A. Pre-engineered shelters.
- B. Electrical wiring and devices for pre-engineered structures.
- C. Heating equipment for pre-engineered structures.
- D. Ventilation equipment for pre-engineered structures.
- E. Air conditioning equipment for pre-engineered structures.

1.2. RELATED SECTIONS

- A. Section 033000 – Cast-In-Place Concrete: Concrete pad.
- B. Sections 260000 through 265600

1.3. REFERENCES

- A. ASTM C 518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM D 256 – Standard Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.
- C. ASTM D 618 – Standard Practice for Conditioning Plastics for Testing.
- D. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
- E. ASTM D 732 – Standard Test Method for Shear Strength Plastics by Punch Tool.
- F. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- G. ASTM D 792 – Standard Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
- H. ASTM D 1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics.
- I. ASTM D 2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

1.4. SUBMITTALS

- A. Submit under provisions of Section 013323.
- B. Product Data: Certified independent test results of representative wall laminate.
- C. Shop Drawings: Show:
 - 1. Critical dimensions, jointing and connections, fasteners and anchors.
 - 2. Materials of construction.
 - 3. Sizes, spacing, and location of structural members, connections, attachments, openings, and fasteners.
 - 4. Color.
- D. Calculations: Structural design calculations, sealed by an independent licensed Professional Engineer.
- E. Samples: 8-inch square sample of representative wall construction, upon request.

- F. Manufacturer's installation instructions.

1.5. SYSTEM DESCRIPTION

- A. Size: provide one-piece molded construction FRP shelter of the following type:
 - 1. Size: 8'-0" W x 8'0" D x 8'0" H.
 - (i) Paneled construction shall not be acceptable.
- B. Design factory-fabricated, pre-engineered to withstand 135 miles per hour wind load, 40 PSF snow load, Seismic Zone 4.

1.6. DELIVERY, STORAGE, AND HANDLING

- A. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

PART 2 – PRODUCTS

2.1. MANUFACTURERS

- A. Engineered Fiberglass Composites, Inc.; 301 Bickford St.; New Lisbon, WI 53950-1524; 608-562-5900; www.engineeredfiberglass.com
- B. TRACOM, Inc.; 6575-A Industrial Way, Alpharetta, Georgia 30004; Tel. (877) 435-8637, Fax (770) 664-6565; www.tracomfrp.com
- C. Warminster Fiberglass Company, P. O. Box 188, Southampton, PA 18966- 0188; <http://www.warminsterfiberglass.com>; Tel. (215) 953-1260, Fax (215) 357-7893.
- D. Requests for substitution must be made in writing in accordance with the General Provisions.
- E. Warranty: Shelters shall be warranted to be free of defects in workmanship and materials for a period of two years from date of shipment.

2.2. MATERIALS

- A. One-Piece Molded Composite Construction:
 - 1. General Construction: The shelter shall be provided with a smooth interior and exterior satin finish. The walls and roof shall be integral with smooth radii for all corners. No roof overhang shall be allowed. External section connection flanges shall only be allowed in those instances where the shelter is oversized.
 - 2. Laminate: Isophthalic polyester resin with high performance, chopped, commercial grade glass strand fiber reinforcement with a suitable coupling agent.
 - a. Minimum glass content: 30%.
 - b. Exterior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a satin finish lightly textured and free from fiber pattern, roughness, or other irregularities.
 - c. Exterior laminate: 1/8-inch-thick (minimum); chemically bonded to the surface gel coat and encapsulating the foam core.
 - d. Interior laminate: 1/8-inch-thick (minimum); chemically bonded to the interior gel coat and encapsulating the foam core.

- e. Interior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a textured finish, free from exposed glass or other irregularities.
- f. Laminate properties:
 - (i) Tensile strength (ASTM D 638): 14,000 PSI.

3. Core

Flexural strength (ASTM D 790)	27,000 PSI
Flexural modulus (ASTM D790)	1,000,000 PSI
Shear strength (ASTM D 732)	12,000 PSI
Barcol hardness (ASTM D 2583)	40
Density / specific gravity(ASTM D 792)	93.6 PCF/1.5

- a. Rigid closed cell, self-extinguishing (Class 1), polyisocyanurate foam with a density of not less than 2.0 pounds per cubic foot.
 - (i) 1 inch thick with minimum initial insulating value of R~6.

b. Core properties:

Thermal conductivity	(ASTM C 518)	0.145 BTU inch/hr./SF/°F
Density / specific gravity	(ASTM D 1622)	2.0 PCF
Shear Strength	(ASTM C 273)	25 lb./in ²
Tensile Strength	(ASTM D 1623)	45 lb./in ²
Compressive Strength (7% deflection/yield)	(ASTM D 1621)	35 lb./in ²

4. Coupons prepared in accordance with ASTM D 618.

- B. The manufacturer shall maintain a continuous quality control program and upon request shall furnish to the ENGINEER certified test results of the physical properties.

2.3. COMPONENTS

A. Doors:

- 1. Quantity:
 - a. [ONE] Double doors.
- 2. Construction:
 - a. One-piece molded fiberglass construction 78 inches high, 1-3/4 inches thick, 63 inches wide (total opening minimum width).

- b. Mount door with two T-304 stainless steel laminated strap hinges, 5 inches long. Door must be readily replaceable – the use of continuous piano hinges or fastening methods other than bolting shall not be acceptable.
 - c. Rubber bulb gasket with flexible lock to retain permanent grip.
 - d. One-piece, purpose built, 3 inches deep fiberglass drip cap over doors; drip cap to extend 2 inches each side past door. Cut angle shall not be acceptable.
 - e. Full threshold, heavy duty black vinyl, 4-1/2 inches deep x 1/2 inch high.
 - f. Schlage stainless steel single-point key locked classroom style ball knob. To facilitate entry and exit from the building, raised or integral door sills shall not be acceptable.
 - g. Heavy duty stainless steel, dual compression spring cushioned overhead door stop, designed for ANSI A156.16.
 - h. Provide single-flap neoprene insert style door sweep.
 - i. Provide 12-inch by 18-inch Lexan window in each door
- B. Door activated mini-switch (for light and fan operation)
- C. Steel Lifting Eyes: Provide a minimum of two removable, 3/4 inch partially threaded, eye bolts with 6-inch shank lengths; 5,200 lbs. work load limit.
- D. Internal Mounting Flange: 3 inches wide x 1/4-inch-thick (minimum) with closed cell neoprene sponge rubber gasket 1-1/4 inches wide x 3/8 inch thick to provide a weather tight seal around the building perimeter.

2.4. EQUIPMENT

A. Electrical

- 1. Circuit Breaker Panel: 120 / 240 VAC, 1 phase, surface mount.
 - a. 125-amp, main breaker, 12 branch, NEMA 3R metallic body
- 2. Electrical Wiring:
 - a. 12 gauge stranded, color-coded THHN/THWN/MTW electrical wiring in rigid, U.L. listed, corrosion / impact resistant, non-conductive, Schedule 40 PVC conduit.
 - b. SO cord or other non-encased wiring shall not be acceptable.
- 3. Receptacle: GFCI receptacle 15A 125V, 20 A 125V feed-through, with 5mA +/- 1mA trip threshold.
 - a. Interior.
- 4. Switch: Weatherproof switch box.
 - a. Single toggle, for light / fan.

B. HVAC

- 1. Fan: Shutter-mounted exhaust fan with integral gravity shutter, aluminum fan blades, fiberglass canopy, and OSHA compliant polyester-coated wire guard. Exhaust fan to be wired to the weatherproof light / fan switch.
 - a. 585 CFM 10-inch diameter fan.
- 2. Heater: Line powered wall heater. No separate electrical outlet shall be required.

- a. 1,500 watt, 5,120 BtuH, white powder coat finish with automatic re-set thermal overload protection with indicator light and built-in thermostat.
- 3. Shutter: Gravity operated fiberglass intake shutter, with heavy duty fiberglass frame and exterior removable T-316 stainless steel insect screen.
 - a. 10 inches by 10 inches.
- C. Lighting
 - 1. Interior Light: Lamp to be wired to the weatherproof light / fan switch.
 - a. 100-watt, vapor-tight incandescent light.
- D. Mounting
 - 1. Equipment mounting panel: 3/4 inches thick plywood equipment mounting panel laminated into wall.
 - a. 42 inches wide x 48 inches high.

2.5. FINISHES

- A. Exterior Color: #2445 Gray Cloud.
- B. Interior Color: #2445 Gray Cloud.

PART 3 – EXECUTION

3.1. EXAMINATION

- A. Verify that the concrete slab is level, true to plane, and of the correct dimensions to receive the structure. Correct all deficiencies before proceeding.

3.2. INSTALLATION

- A. Install products in accordance with ENGINEER's instructions, plans, blueprints, etc., local codes, and in a manner consistent with the installation instruction and recommendation of the manufacturer.
- B. DO NOT remove the door spacers until ALL ANCHOR BOLTS have been COMPLETELY SET and door operation has been VERIFIED.**
- C. Move and position the shelter using the lifting eyes provided. The neoprene gasket provided should be positioned between the concrete slab and the building mounting flange. If more than one lifting eye is provided **USE A SPREADER BAR.**
- D. After closing the shelter doors:
 - 1. Layout the anchor bolt pattern. The anchor bolts should be installed in accordance with the ENGINEER's instructions.
 - 2. Drill and set the anchor bolts starting with one on each side of the doors. The anchor bolts behind and in front of the doors should be flat head anchors if the mounting flange is external.
 - 3. Drill the anchor bolt holes to the depth and diameter required by the anchor bolt manufacturer. Stainless steel wedge style concrete anchors [1/2-inch diameter x 4-1/2 inches long – (minimum)] are recommended. Anchor bolts are to be supplied by others.

4. Verify the operation of the doors before installing the remaining anchor bolts.
 - a. FAILURE to VERIFY the operation of the doors BEFORE the remaining anchor bolts are set MAY RESULT in the BINDING of the door against the door frame.
5. Install the threshold (if supplied) and re-verify the operation of the doors.
6. After all anchor bolts have been completely set, remove the door spacers.
- E. Seal the flange with sealant or grout to ensure watertightness.
- F. Install (as necessary) and test the shelter accessories in accordance with the manufacturers' instructions.

3.3. ADJUST AND CLEAN

- A. Clean surfaces in accordance with the manufacturer's instructions.
- B. Remove trash and debris and leave the site in a clean condition.

END OF SECTION

SECTION 400519 – DUCTILE IRON PROCESS PIPE

PART 1 – GENERAL

1.1. SUMMARY

- A. Furnish labor, materials, equipment, and incidentals necessary to install ductile-iron pressure pipe, including connections and appurtenances as required for the proper installation and function of the system.
- B. Polyethylene encasement for ductile iron pipe is detailed in this Section.

1.2. REFERENCES

A. Reference Standards

- 1. Reference standards cited in this specification refer to the current reference standard published at the time of the latest revision date logged at the end of this specification, unless a date is specifically cited.
- 2. American National Standards Institute (ANSI)/American Water Works Association (AWWA)
 - a. ANSI/AWWA C104/A21.4 - American National Standard for Cement - Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - b. ANSI/AWWA C105/A21.5 - American National Standard for Polyethylene Encasement.
 - c. ANSI/AWWA C111/A21.11 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - d. ANSI/AWWA C115/A21.15 - American National Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - e. ANSI/AWWA C150/A21.50 - American National Standard for the Thickness Design of Ductile-Iron Pipe.
 - f. ANSI/AWWA C151/A21.51 - American National Standard for the Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
 - g. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - h. AWWA M-41 - Ductile-Iron Pipe and Fittings.

1.3. ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4. SUBMITTALS

- A. Submittals shall be in accordance with Section 013323.
- B. All submittals shall be approved by the ENGINEER or the OWNER prior to delivery and/or fabrication for specials.

1.5. ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

- A. Product Data

1. Submittal for painting exterior pipe to include recommendation for preparation, application and storage.
- B. Shop Drawings
 1. Prior to the fabrication of the pipe, submit Record Data of fabrication and laying drawings to the OWNER for review of general conformance to contract documents. Record Data shall include a complete description of the pipe offered including cuts and tabulated layout. Record Data shall include a pipe layout table showing pipe joints, fittings, and appurtenances, utilizing stationing, or northings and eastings matching that shown on the plans. Pipe layout table shall show pipe class, class coding, station limits and transition stations for various pipe classes.
- C. Certificates
 1. Prior to delivery of the pipe to the project site, the manufacturer shall furnish an affidavit certifying that all pipe, fittings, and specials, and other products and materials furnished, comply with this specification. If requested by the OWNER, the manufacturer shall submit certified reports of all testing.
- 1.6. CLOSEOUT SUBMITTALS [NOT USED]
- 1.7. MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
- 1.8. QUALITY ASSURANCE
 - A. Manufacturer: Finished pipe shall be the product of one (1) manufacturer. Pipe manufacturing operations (pipe, fittings, lining, coating) shall be performed at one (1) location.
- 1.9. DELIVERY, STORAGE, AND HANDLING
 - A. Delivery and Storage shall be in accordance with ANSI/AWWA C600 and AWWA M41.
- 1.10. FIELD CONDITIONS [NOT USED]
- 1.11. WARRANTY [NOT USED]

PART 2 – PRODUCTS

- 2.1. DUCTILE IRON PIPE
 - A. Manufacturers
 1. The following manufacturers are acceptable
 - a. American Cast Iron Pipe Company
 - b. US Pipe
 - c. Or Approved Equal
 - B. Regulatory Requirements
 1. Pipe shall be in accordance with AWWA C110, AWWA C111, AWWA C115, AWWA C150, and AWWA C151.

C. Performance/Design Criteria

1. All pipe and fittings shall be restrained.
 - a. Above grade pipe and fittings shall be flanged unless otherwise specified in the drawings.
 - b. Buried pipe shall have restrained push-on joints.
 - c. Buried fittings shall be provided with mechanical joints and shall be restrained with Megalugs or approved equal.

2. Pressure Rating

- a. Working pressure - 35 psi.
 - b. Total pressure (Working + Surge) – 110 psi
 - c. Test Pressure – Per AWWA C600
 - d. As a minimum standard, the following pressure classes shall apply

<u>Diameter Pipe (inch)</u>	<u>Min. Pressure Class (PSI)</u>
3" through 12"	350 psi

3. Ductile iron pipe shall have nominal lay lengths of 18 or 20 feet. Dimensions and tolerances of each nominal pipe size shall be in accordance with ANSI/AWWA C151/A21.
4. Pipe markings shall meet the minimum requirements of ANSI/AWWA C151/A21, latest revision. Minimum pipe markings shall be as follows:
 - a. "DI" or "DUCTILE" shall be cast or metal stamped on each pipe
 - b. Weight, pressure class, and nominal thickness of each pipe
 - c. Year and country pipe were cast
 - d. Manufacturer's mark
5. Joints
 - a. Comply with ANSI/AWWA C111/A21.11, latest revision.
 - (i) Push-On Joints – Joints shall be Fastite as manufactured by ACIPCO or Tyton as manufactured by US Pipe. No other joint type will be allowed.
 - (ii) Mechanical Joints
 - (iii) Restrained Joints – Joints shall be Flex-Ring or LOK-Ring as manufactured by ACIPCO, TR Flex as manufactured by US Pipe, or approved equal. No other joint type will be allowed.
 - (iv) Flanged Joints – AWWA C115/A21.15, ANSI B16.1, Class 125
 - b. All rubber joint gaskets utilized on ductile-iron pipe shall be in conformance with ANSI/AWWA C111/A21.11, latest revision.

D. Materials

- (i) Iron used in the manufacture of pipe for these specifications shall have:
 - (ii) Minimum tensile strength – 60,000 psi

- b. Minimum yield strength – 42,000 psi
- c. Minimum elongation – 10%
- 2. Bolts and Nuts
 - a. For buried applications, provide ASTM A193 Grade B8M bolts and ASTM A194 Grade 8M Nuts.
 - b. All buried T-bolts shall be 316 stainless steel.
 - c. All non-buried bolts and nuts for mechanical joints or flanged ends shall be of a high strength corrosion resistant low-alloy steel in accordance with ANSI/AWWA C111/A21.11 and ASTM A307, “Standard Specification for Carbon Steel Bolts and Nuts”.
 - (i) The bolts and nuts shall be coated with a ceramic-filled, baked on fluorocarbon resin.
 - (ii) Coated bolts and nuts shall be prepared “near white” or “white” when coated to manufacturer’s recommended thickness by a certified applicator.
 - (iii) Coating shall be Xylan®, as manufactured by Whitford Corporation, or approved equal.
 - (iv) Coating shall conform to the performance requirements of ASTM B117, “Salt Spray Test” and shall include, if required, a certificate of conformance”

E. Lining and Coating

1. Exterior Coating

- a. Buried
 - (i) Asphaltic coating, minimum of 1 mil thickness
- b. Exposed (Above Ground)
 - (i) Pipe and fittings exposed to view in the finished work shall not receive the standard asphaltic coat on the outside surfaces, but shall be shop-coated with rust inhibitive primer. Primer shall have a minimum dry film thickness of 4 mils. Exposed piping shall be coated with a minimum of 12-mil Acrylic Polyurethane as manufactured by TNEMEC, Sherwin-Williams, or approved equal.
 - (ii) Color shall match service (brown for sludge)

2. Interior Lining

- (i) All ductile iron pipe shall have an approved corrosion resistant lining applied to the interior. Lining shall be Protecto 401 or approved equal applied to 40-mil DFT minimum.

2.2. POLYETHYLENE ENCASEMENT:

- A. All buried ductile iron pipe and fittings shall be polyethylene encased in accordance with AWWA C105.

- B. Use only virgin polyethylene material.
- C. Encasement for buried pipe shall be V-Bio enhanced polyethylene. Encasement shall be composed of three layers of co-extruded linear low-density polyethylene (LLDPE) film fused into one conforming to AWWA C105/A21.5.
- D. Polyethylene film must be marked as follows:
 - 1. Manufacturer's name or trademark
 - 2. Year of manufacturer
 - 3. ANSI/AWWA C105/A21.5
 - 4. Minimum film thickness and material type
 - 5. Applicable range of nominal diameter size(s).
 - 6. Warning-Corrosion Protection-Repair Any Damage
- E. Special Markings/Colors
 - 1. Perform one of the following:
 - a. Label polyethylene encasement with "SLUDGE";
 - b. Provide brown polyethylene in accordance with the American Public Works Association Uniform Color Code; or
 - c. Attach sanitary sewer marker tape to the polyethylene wrap.

PART 3 – EXECUTION

3.1. GENERAL

- A. Install pipe, fittings, and appurtenances as special in accordance with AWWA M41, AWWA C600, and in accordance with the pipe manufacturer's recommendations.
- B. Polyethylene encasement shall be installed in accordance with AWWA C105 and AWWA M41, Method A or B. Method C will not be allowed.
- C. All fittings shall be mechanically restrained.

3.2. PIPE HANDLING

- A. Haul and distribute pipe and fittings at the project site.
- B. Handle piping with care to avoid damage.
 - 1. Inspect each joint of pipe and reject or repair any damaged pipe prior to lowering into the trench.
 - 2. Do not handle the pipe in such a way that will damage the interior lining.
 - 3. Use only nylon ropes, slings or other lifting devices that will not damage the surface of the pipe for handling the pipe.
- C. At the close of each operating day:
 - 1. Keep the pipe clean and free of debris, dirt, animals and trash – during and after the laying operation.
 - 2. Effectively seal the open end of the pipe using a gasketed night cap.

3.3. JOINT MAKING

A. Mechanical Joints

1. Assemble mechanical joints in accordance with ANSI/AWWA C111/A21.11 Appendix A, AWWA C600 and AWWA Manual M41.
2. Bolt the follower ring into compression against the gasket with the bolts tightened down evenly then cross torqued in accordance with AWWA C600.
3. Overstressing of bolts to compensate for poor installation practice will not be permitted.

B. Push-on Joints

1. Install Push-on joints as defined in AWWA/ANSI C111/A21.11.
2. Wipe clean the gasket seat inside the bell of all extraneous matter.
3. Place the gasket in the bell in the position prescribed by the manufacturer.
4. Apply a thin film of non-toxic vegetable soap lubricant to the inside of the gasket and the outside of the spigot prior to entering the spigot into the bell.
5. When using a field cut plain end piece of pipe, refinish the field cut and scarf to conform to AWWA C600.

C. Flanged Joints

1. Install in accordance with ASME PCC-1-2012.
2. During assembly, tighten nuts gradually and equally using a three-pass method in accordance with ASME PCC-1-2012.
 - a. For the first pass, tighten the nuts to 50 percent at diametrically opposite sides to prevent misalignment and to ensure that all bolts carry equal loads.
 - b. For the second pass, tighten the nuts to 100 percent again in a diametrically opposite pattern.
 - c. Allow a minimum of 1 hour to pass to provide time for settlement between bolts and nuts and gasket relaxation.
 - d. Complete the third pass by checking each bolt in a clockwise pattern. Each nut should be tightened until it will no longer turn. This step compensates for elastic interaction and brings all bolts into parity.
3. The threads of the bolts should protrude a minimum of ½-inch from the nuts.
4. The fitting must be free to move in any direction while bolting.
 - a. Install flange bolts with all bolt heads faced in one direction.

D. Joint Deflection

1. No deflection of the pipe at joints will be allowed. All pipe deflection shall take place at fittings.

3.4. POLYETHYLENE ENCASEMENT INSTALLATION

A. Preparation

1. Remove all lumps of clay, mud, cinders, etc., on pipe surface prior to installation of polyethylene encasement.
 - a. Prevent soil or embedment material from becoming trapped between pipe and polyethylene.
 2. Fit polyethylene film to contour of pipe to affect a snug, but not tight encasement with minimum space between polyethylene and pipe.
 - a. Provide sufficient slack in contouring to prevent stretching polyethylene where it bridges irregular surfaces such as bell-spigot interfaces, bolted joints or fittings and to prevent damage to polyethylene due to backfilling operations.
 - b. Secure overlaps and ends with adhesive tape and hold.
 3. For installations below water table and/or in areas subject to tidal actions, seal both ends of polyethylene tube with adhesive tape at joint overlap.
- B. Tubular Type (Method A)
1. Cut polyethylene tube to length approximately 2 feet longer than pipe section.
 2. Slip tube around pipe, centering it to provide 1-foot overlap on each adjacent pipe section and bunching it accordion-fashion lengthwise until it clears pipe ends.
 3. Lower pipe into trench and make up pipe joint with preceding section of pipe.
 4. Make shallow bell hole at joints to facilitate installation of polyethylene tube.
 5. After assembling pipe joint, make overlap of polyethylene tube, pull bunched polyethylene from preceding length of pipe, slip it over end of the new length of pipe and wrap until it overlaps joint at end of preceding length of pipe.
 6. Secure overlap in place.
 7. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points.
 8. Repair cuts, tears, punctures or other damage to polyethylene.
 9. Proceed with installation of next pipe in same manner.
- C. Tubular Type (Method B)
1. Cut polyethylene tube to length approximately 1 foot shorter than pipe section.
 2. Slip tube around pipe, centering it to provide 6 inches of bare pipe at each end.
 3. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points; secure ends.
 4. Before making up joint, slip 3-foot length of polyethylene tube over end of proceeding pipe section, bunching it accordion-fashion lengthwise.
 5. After completing joint, pull 3-foot length of polyethylene over joint, overlapping polyethylene previously installed on each adjacent section of pipe by at least 1 foot; make each end snug and secure.
- D. Sheet Type
1. Cut polyethylene sheet to a length approximately 2 feet longer than piece section.

2. Center length to provide 1-foot overlap on each adjacent pipe section, bunching it until it clears the pipe ends.
 3. Wrap polyethylene around pipe so that it circumferentially overlaps top quadrant of pipe.
 4. Secure cut edge of polyethylene sheet at intervals of approximately 3 feet.
 5. Lower wrapped pipe into trench and make up pipe joint with preceding section of pipe.
 6. Make shallow bell hole at joints to facilitate installation of polyethylene.
 7. After completing joint, make overlap and secure ends.
 8. Repair cuts, tears, punctures or other damage to polyethylene.
 9. Proceed with installation of next section of pipe in same manner.
- E. Pipe-Shaped Appurtenances
1. Cover bends, reducers, offsets and other pipe-shaped appurtenances with polyethylene in same manner as pipe and fittings.
- F. Odd-Shaped Appurtenances
1. When it is not practical to wrap valves, tees, crosses, and other odd-shaped pieces in tube, wrap with flat sheet or split length polyethylene tube by passing sheet under appurtenances and bringing it up around body.
 2. Make seams by bringing edges together, folding over twice and taping down.
 3. Tape polyethylene securely in place at the valve stem and at any other penetrations.
- G. Repairs
1. Repair any cuts, tears, punctures or damage to polyethylene with adhesive tape or with short length of polyethylene sheet or cut open tube, wrapped around fitting to cover damaged area and secured in place.
- H. Openings in Encasement
1. Provide openings for branches, service taps, blow-offs, air valves and similar appurtenances by making an X-shaped cut in polyethylene and temporarily folding back film.
 2. After appurtenance is installed, tape slack securely to appurtenance and repair cut, as well as other damaged area in polyethylene with tape.
 3. Service taps may also be made directly through polyethylene, with any resulting damaged areas being repaired as described above.
- I. Junctions between Wrapped and Unwrapped Pipe:
1. Where polyethylene-wrapped pipe joins an adjacent pipe that is not wrapped, extend polyethylene wrap to cover adjacent pipe for distance of at least 3 feet.
 2. Secure end with circumferential turns of tape.
 3. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric tape for minimum clear distance of 3 feet away from Cast or Ductile Iron Pipe.

END OF SECTION

SECTION 400562 – PLUG VALVES

PART 1 – GENERAL

1.1. SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to install and put into operation, plug valves as specified herein and shown on the drawings.
- B. Valves shall be 6-in DeZURIK PEC Eccentric Plug Valve, Cast Iron Body, Flanged End connection (ASME 125/150# Drilling), Buna-N packing material, Chloroprene plug facing, Fusion Bonded Epoxy on Interior and Exterior, Manual Worm Gear Actuator & Handwheel, 316 SS Exterior Bolting, Factory Standard Seat and Shell Test Certification, or approved equal.

1.2. QUALITY ASSURANCE

- A. References:
 - 1. AWWA C517-16 Resilient-Seated Cast-Iron Eccentric Plug Valves

1.3. SUBMITTALS

- A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the OWNER. Warranty shall be for a period of two years and begin on the same date as the maintenance bond.

PART 2 – PRODUCTS

2.1. PLUG VALVES

- A. Requirements
 - 1. The CONTRACTOR shall furnish and install plug valves as manufactured by DeZurik Corporation or approved equal. Plug valves shall be manufactured in accordance with AWWA C-504 and shall be of the 1/4 turn, eccentric non-lubricated type, serviceable under full line pressure, and capable of sealing in both directions at the rated pressure. Plug valves shall have a minimum port area of 80% of the nominal pipe size.
- B. Materials

1. The valve body shall be of cast iron, 30,000 psi tensile strength, with added nickel and chromium, ASTM A126, Class B, 175 psi rating. The valve plug shall be cast iron conforming to ASTM A126, Class B, with neoprene resilient facing. The valve seating design shall be resilient and of the continuous interface type having consistent opening/closing torques, and shall be non-jamming in the closed position. Closure shall be accomplished by means of an offset plug design with a resilient seating face that achieves full 360-degree seating contact. Valves shall be of the bolted bonnet design. The resilient faced plug shall be replaceable without removing the valve body from the line. The valve body seating area shall be corrosive resistant by a welded-in overlay of high nickel content. Sprayed or plated seating surfaces will not be acceptable. Valves shall have permanently lubricated Type 316 stainless steel bearings on the upper and lower plug stem journal. Bearings shall be replaceable. Packing shall be Buna N (Vee Type). Valves shall be designed such that they can be repacked without removing the bonnet. All exposed nuts, bolts, springs, and washers shall be stainless steel. Valves shall be flanged.
- C. Actuators
 1. Plug valves shall be equipped with worm gear actuators. All gearing shall be enclosed suitable for running in oil with seals provided on all shafts to prevent entry of dirt and water into the actuator. All shaft bearings shall be furnished with permanently lubricated bronze or stainless-steel bearing bushings. Actuator shall clearly indicate valve position and an adjustable stop shall be provided. Construction of actuator housing shall be semi-steel. Hardware on actuators shall be of the same materials as the valves.
- D. Plug valves in buried service shall be provided with a polyethylene coating.
- E. Plug valves for buried service shall be furnished with a square 2" operating nut. The valve box shall conform to County Standards.
- F. Installation
 1. Plug valves shall be installed such that the direction of flow through the valve is in accordance with the manufacturer's recommendations.

PART 3 – EXECUTION

3.1. GENERAL

- A. All work shall be performed by skilled craftsmen qualified to perform the required work in a manner comparable with the best standards of practice.
- B. The CONTRACTOR shall provide a supervisor at the work site during all construction operations. The supervisor shall have the authority to sign change orders, coordinate work and make decisions pertaining to the fulfillment of the contract.
- C. The CONTRACTOR and all workmen employed by him shall conduct all operations in a clean and sanitary manner and in conformance with all aspects of the contract documents.

END OF SECTION

SECTION 409513 – INSTRUMENTATION AND CONTROL GENERAL

PART 1 – GENERAL

1.1. WORK OF THIS SECTION

- A. The WORK of this Section includes the general specification and requirements for the instrumentation and controls work under this and other applicable Specifications.
- B. The CONTRACTOR, shall furnish, install, and place into service the operating process instrumentation, control systems, and all appurtenant work, all in accordance with the requirements of the Contract Documents. The Contractor's attention is directed to the electrical and mechanical schematics and details of this project. Referral to these portions of the Contract Documents shall be required in order to understand the full intent and scope of work required.
- C. The Contractor shall coordinate all requirements with the equipment manufacturers and suppliers at bid time to provide for a complete and operable system and shall include all costs in its bid to add additional instruments, wiring, computer inputs/outputs, controls, conduit, interlocks, electrical hardware, drawing revisions etc., into the design based on Equipment Manufacturer's requirements and final certified prints to meet the specifications. Such changes to instrumentation and electrical work to meet the specification requirements shall be incorporated into the scope of work at no additional cost to the Owner.
- D. The Contractor shall perform field engineering as required for mounting and supporting all field mounted components. The Contractor shall develop any additional schematic and interconnection diagrams required to interface with existing systems, PLC and instrumentation equipment, which may be required for a complete and operable instrumentation and controls.
- E. All work in this section relates to field level devices and connectivity of only new control related equipment and implies that Owner will not be responsible for any programming or SCADA beyond the plant level. All new equipment must be observed to be functional and controllable by existing plant controller.
- F. The Contractor shall procure, fabricate, assemble, program and configure the local instrumentation and control panels based on the requirements of Sections 260000 through 265600, and related Mechanical and Civil Divisions.
- G. Instrumentation materials, process wetted parts and installations shall be designed to be compatible with the process media, area environment and classification in which it shall operate.
- H. Instrument installation shall provide for unobstructed access to the instruments for calibration, diagnostics and process display. Instrumentation displays shall be protected from direct sunlight exposure and shall be provided with sunshields per drawing E-07 Detail(s) F, G, as required to provide legible display viewing during daylight hours at a 24" viewing distance.

1.2. EXISTING CONTROL SYSTEMS

- A. The Contractor shall field verify the existing PLC wiring, configuration and programming applications prior to any PLC system modifications. The Contractor shall provide a technician to upload the existing program and document the I/O configuration prior to any programming modifications. The field verifications and program upload will formulate the as-built and as programmed configurations prior to modification.
- B. The Contractor shall field verify all existing instrumentation and control logic systems prior to implementing the specified modifications. The operation of switches, relays and interlocking logic shall be confirmed to operate in either the Normally Open or Normally Closed states. The Contractor shall provide interposing relays and wiring modifications necessary to meet the operational requirements specified.
- C. All new custom control panels and manufacturer control panels are required to be connected to plant wide control system by contractor and demonstrated, by test program, to be able to be either controlled, monitored, or both by existing plant wide control system. Contractor to verify all power and communication connections are in place. Owner agent to be responsible for specific programming of systems.

1.3. RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK with respect to interfacing electrical and control systems packaged under the mechanical and civil specification sections.
- B. Division 26 Electrical

1.4. CODES

- A. WORK of this Section shall comply with the current editions of the following codes:
 - 1. Uniform Fire Code
 - 2. National Electrical Code
 - 3. NEMA

1.5. SPECIFICATIONS AND STANDARDS

- A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:
 - 1. ISA-RP60.6 – Nameplates, Labels, and Tags for Control Centers
 - 2. ISA-RP12.6 – Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
 - 3. ISA-S5.1 – Instrument Symbols and Identification
 - 4. ISA-S5.4 – Instrument Loop Diagrams
 - 5. ISA-S20 – Specification Forms for Process Measurement and Control Instrumentation; Primary Elements and Control Valves

1.6. FIELD INSTRUMENTATION

- A. Field instruments shall be provided based on these current specifications, as well as supplied contract documents.

B. Control panel submittals

1. Control panel submittals shall be grouped by location, area and process. Bill of Materials and fabrication drawings shall be individually grouped by Facility, Area and control panel.
2. A separate technical brochure or bulletin shall be included for each instrument, and equipment item, system, and other element. The brochures shall be indexed by systems or loops. If, within a single system or loop, a single item is employed more than once, one brochure may cover all identical uses of that item in the system. Each brochure shall include a list of tag numbers to which it applies. System groups shall be separated by labeled tags.
3. Schematic and wiring diagrams for control circuits shall be submitted in two stages. Initially, schematic control diagrams shall show complete details on the circuit interrelationships of all devices within and outside each Control Panel. Subsequent to acceptance of all schematic control diagrams, by the Engineer, piping and wiring diagrams shall be submitted. The diagrams shall consist of component layout drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as pumps, valves, chemical feeders and local control panels. Wiring diagrams shall include MCC Panel, circuit, and breaker number for each power feed
4. Assembly and construction drawings for each alarm annunciator, local indicating panel, process control panel and for other special enclosed assemblies for field installation. These drawings shall include dimensions, identification of all components, surface preparation and finish data, and nameplates. These drawings also shall include enough other details, including photographs, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.
5. Installation, mounting, and anchoring details for all components and assemblies to be field-mounted, including conduit connection or entry details.
6. Complete control panel layouts, all drawn to a 1-1/2 inch=1-foot scale showing:
 - a. Physical arrangements which define and quantify the physical groupings of, PLC components, annunciators, handstations, recorders, indicators, pilot lights and all other instrumentation devices associated with control panel sections, auxiliary panels, subpanels and racks.
 - b. All cutout locations fully dimensioned.
 - c. All outside panel dimensions shall be shown.
 - d. Locations of back-of-panel stiffeners.
 - e. Backpanel equipment layout and terminal point locations for all panel and back-of-panel piping and wiring connections. Terminations shall be coded with identifiers for wiring and piping connections for all electric, hydraulic and pneumatic terminations
7. Bill of Material

- a. A complete and detailed bill of material list shall be submitted for each field mounted device or assembly as well as cabinet assemblies and subassemblies. Bills of material shall include all items within an enclosure. An incomplete submittal shall be rejected and no further evaluation performed until a complete and detailed bill of material is submitted.
8. Panel Power and Heating: Provide calculations as required, and determine panel power required, heat dissipation, and operating temperature. Power requirements shall state required voltages, currents, and phases. Heat dissipation shall be at maximum and shall be stated in BTU per hour or watts. Operating temperature shall be calculated at specified ambient temperatures or at 40 degrees C, if no other ambient temperature is specified. If ventilation fans are used, provide audible sound level for the fans.

C. FIELD INSTRUMENTATION

1. Instrumentation Summary/Schedule and Bill of Material
2. Technical brochures, bulletins and data sheets containing:
 - a. Fully completed ISA S20 data sheets
 - b. Technical Specification Data Sheets
 - c. Component functional descriptions
 - d. Locations or assembly at which component is to be installed
 - e. Materials of a component's parts which will be in contact with process fluids or gases
3. Instrumentation Loop Diagrams per ISA S-5.4

D. FACTORY TESTING

1. The Manufacturer shall prepare a factory test procedure. The procedure shall be written as a cause and effect procedure that address the following.
 - a. Input/output wiring and operation.
 - b. Analog signal wiring and range
 - c. Communications integrity
 - d. Control System Operation
2. Control system tests forms shall be prepared on a loop by loop, process by process basis. The form shall identify operation of the control loop and provide sign-off for all setpoint trips, operations and control actions provided by the control loop.
3. Each form shall be provided with a sign-off location.
4. The Contractor shall provide all necessary hardware and systems necessary to fully demonstrate the operation of the plant control systems.

E. SYSTEM START-UP AND COMMISSIONING

1. The Contractor shall provide comprehensive-testing procedures, forms and reports complete.

2. Testing submittals shall address the testing and commissioning requirements for all process controls, instrument loops, discrete monitoring points and associated control actions.
3. Test submittals shall be provided with the following:
 - a. Instrument Calibration Forms
 - b. Loop test and verification Forms
 - c. Process Control Test Forms
 - d. Input/output Test Forms
 - e. Communication Test Forms
 - f. Field Switch calibration and adjustment forms

1.7. PROJECT MEETINGS

- A. Attend meetings as specified and required to meet the needs of the project based on its size, scope and complexity in relation to the Instrumentation and Controls.
- B. At a minimum, the Contractor shall attend the following meetings:
 1. System Start-up and Commissioning

1.8. COORDINATION

- A. Electrical Equipment Supplier
 1. The Contractor shall coordinate protective circuit requirements with the equipment supplier. The Contractor shall obtain from the supplier the protective devices required by the manufacturer to maintain the warranty of the equipment. The Contractor shall install and wire the protective circuitry in accordance with the manufacturer's requirements.

1.9. SERVICES OF MANUFACTURER

- A. Calibration, Testing and Startup: The contractor shall provide the services of technical service representative of the manufacturer who shall visit the site and perform the following on all flow meters and chemical system analyzers.
 1. Inspection, checking and calibrating the equipment
 2. Startup and field testing for proper operation
 3. Performing field adjustments to ensure that installation and operation comply with the Specifications
- B. Instruction of OWNER'S Personnel: The manufacturer's technical service representative shall instruct the OWNER'S personnel

1.10. SPECIAL GUARANTEE

- A. The Contractor shall guarantee the WORK of this section for one year following final acceptance of the WORK. In making any warranty repairs, the Contractor shall utilize technical service personnel designated by the manufacturer of the failed device. Repairs shall be completed within 5 days after written notification by the OWNER.

1.11. PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials: Products delivered to the site for incorporation into the WORK of this Section shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- B. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements. Installed Equipment: Equipment installed in place for periods exceeding 24 hours prior to the field wiring and commissioning of electrical and electronic equipment shall be protected from dust and exposure to the elements.
- C. Shipment: Panels shall be crated for shipment using a heavy framework and skids. Panel sections shall be cushioned to protect the finish of the instruments and panel during shipment. Instruments, which are shipped with the panel, shall have suitable shipping stops and cushioning material installed to protect instrument parts from mechanical shock damage during shipment. Each panel crate shall be provided with removable lifting lugs to facilitate handling

1.12. ENVIRONMENTAL CONDITIONS

- A. General: All instrumentation and control system components and associated wiring shall be suitable for use in an environment where there may be high energy AC fields, DC control pulses, and varying ground potentials between transducers and system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.
- B. Field Situated Equipment: The system design shall be adequate to provide proper protection in the environment typically associated with these facilities. As a minimum, the instrumentation and control systems shall be designed and constructed for satisfactory operation and low maintenance requirements under the following environmental conditions:
 - 1. Temperature Range: 0 through 60 degrees C (32 - 144 degrees F)
 - 2. Thermal Shock: 0.55 degrees C per minute (1.0 degrees F per minute)
 - 3. Relative Humidity: 20 - 95 percent (non-condensing)
- C. Noise Tolerance: The instrumentation and control system components shall not exceed a dB level of 55 when monitored 3-feet away from the devices. If upon testing it is found that this limit is exceeded at the option of the ENGINEER and at no additional cost to the OWNER, devices shall be replaced in order to achieve a maximum level of 55 dB or sound absorption materials shall be added.
- D. Equipment panels shall be constructed with Sun Shield per E-07 Details F, G.

1.13. EQUIPMENT GENERAL

- A. All meters, all instruments, and all other components shall be of the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise indicated.
- B. Outdoor instrumentation and control panels shall be suitable for operation in the ambient conditions at the equipment installation locations. Heating, cooling, and dehumidifying devices shall be incorporated with the outdoor instrumentation in order to maintain it within its rated environmental operating ranges.

- C. All instrumentation and equipment items in hazardous areas shall be intrinsically safe or be approved for use in the particular hazardous classification in which it is to be installed.
- D. Mercury switches and components containing liquid mercury shall not be used.
- E. Analog measurements and control signals shall be electrical and shall vary in direct linear proportion to the measured variable, except as indicated. Electrical signals outside control board(s) shall be 4-20mA DC except as noted.

1.14. INSTRUMENTATION AND CONTROL PANELS

A. General:

1. Equipment Framework and Supports:

- a. The rear of each control panel section or Instrument wall panel shall have a steel framework for supporting conduit, tubing, wireways, switches, air piping and all instrument accessory items such as relay or terminal enclosures, transducers, pressure switches, valves and air relays. The main frame work shall be constructed of standard structural shapes. Special shapes such as "Unistrut" may be used for secondary supports. Framework must not interfere with instrument connections or access needed for maintenance or adjustments.

1.15. INSTRUMENT MOUNTING

- A. The Contractor shall provide field cut-outs, installation mounting racks, bracing, shelving and stanchions, and shall mount all instrument and control items indicated, including any instruments indicated to be furnished by the Owner or other manufacturers.
- B. The Contractor shall also mount, behind existing panels, other instrument accessory items as indicated or necessary for interfacing with existing equipment.
- C. Control Panel Requirements:
 - 1. The Contractor shall provide all wiring, conduit, wireways, and switches required to make instruments and other panel electrical devices operational.
 - 2. Unless otherwise specified, wiring methods and materials for all panels shall be in accordance with the NEC requirements.
 - 3. Soldered or pressure crimped wire splicing in conduits, panels or wireways shall not be acceptable.
- D. Instrumentation Requirements:
 - 1. Instruments located on a single panel section that serve one process unit may be connected to a common branch power circuit. The number of branch circuits shall be such that no circuit load exceeds 10 amps. Different panel sections and instruments serving different process units shall not use common branch circuits. A 15-amp, two-pole circuit breaker shall be provided in each branch circuit.
 - 2. When instruments not equipped with integral fuses, the contractor shall furnish and install fuses as required for the protection of individual instruments and equipment against fault currents. Fuses shall be mounted on the back of the panel, in a fuseholder, with each fuse identified by a service name tag.

3. Each potentiometer type instrument, electronic transducer, controller or analyzer shall have an individual disconnect switch. Disconnect switches shall have metal or plastic tags listing the associated instrument tag numbers. Individual plug and cord set power supply connections may be used without switches when indicated.
4. Remote I/O (RIO) and Modbus Plus (MB+) cabling shall be provided, installed and terminated in accordance with the manufacturers cabling and termination procedures.
- E. Color Conventions: Lens covers/LED's for indicating lights on all panels will be colored as follows:
 1. Red-ON when;
 - a. Motor not running (STOPPED)
 - b. Valve CLOSED (not fully opened)
 - c. Device not energized.
 - d. Circuit breaker OPENED
 2. Green-ON when;
 - a. Motor running in forward direction (fast speed for multi-speed motors).
 - b. Valve OPEN (not fully closed)
 - c. Device energized.
 - d. Circuit breaker CLOSED
 3. White-ON when;
 - a. Power available
 - b. System in AUTOMATIC mode.
 - c. Monitoring taking place
 4. Amber-ON when;
 - a. Malfunction trip.
 - b. Equipment locked out.
 - c. Alarm condition

1.16. NAMEPLATES

- A. Nameplates shall be provided for all instruments, function titles for each group of instruments, and other components mounted on the front panel(s) as indicated. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, and electronic trip mounted inside the panel(s). Nameplates shall be descriptive to define the function and system of such element. These nameplates shall be of the same material as those on the front of the panel(s). Adhesives shall be used for attaching nameplates. Nameplates shall be fabricated from black face white-center laminated engraving plastic. Painted surfaces shall be prepared to allow permanent bonding of adhesives. Colors, lettering, styles, abbreviations and sizes shall be in conformance with ISA_RP60.6 with an intended viewing distance of 3 feet to 6 feet.

- B. Equipment Interior Nameplates Nameplate material shall be clear plastic with black machine printed lettering as produced by a KROY or similar machine; except caution, warning, and danger nameplates shall have red lettering. The size of the nameplate tape shall be no smaller than 1/2" in height with 3/8" lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on a clean surface using the adhesion of the tape. Add additional clear glue to hold the nameplate securely in place when necessary. For each device with a specific identity (relay, module, power supply, fuse, terminal block, etc.) mounted in the interior of a piece of equipment provide a nameplate with the inscription as shown in the Contract documents. Where no inscription is indicated in the Contract documents, furnish nameplates with an appropriate inscription providing the name and number of devices used on the submittal drawings. Stamp the nameplates with the inscriptions as approved by the Engineer in the submittal.
- C. Electrical hazard and foreign voltage nameplates shall be provided for all equipment in accordance with NEC.

PART 2 – PRODUCTS

2.1. GENERAL

- A. Equipment and materials shall be products of reputable, experienced manufacturers. Similar items in the project shall be the products of the same manufacturer. All equipment shall be of industrial grade, a standard of construction, shall be of sturdy design and manufacture, and shall be capable of long, reliable, trouble-free service.
- B. The field equipment panels shall be fabricated to house, controllers, instrumentation and communications equipment specified elsewhere and as indicated on the contract drawings. Control panels shall be fabricated and wired in accordance with applicable specification sections.
- C. Instrumentation control equipment shall be UL listed.

2.2. COMPONENTS GENERAL

- A. Field Terminal Blocks: Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 25 amperes at 600 volts. White marking strips, fastened securely to the molded sections, shall be provided and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid.
- B. Indicators: Indicators shall be provided at the locations specified and shall be rated for the voltage required. Indicators shall be full-voltage Push-To-Test LED.

2.3. GENERAL INSTRUMENTATION AND CONTROL COMPONENTS

- A. Signal Isolators, Converters, and Power Supplies: Signal isolators shall be provided in each measurement and control loop, wherever required, to match adjacent component impedances, provide signal amplification, or where feedback paths may be generated or to maintain loop integrity when the removal of a component of a loop is required. Signal converters shall be provided where required to resolve any signal incompatibilities. Signal power supplies shall be provided to supply sufficient power to each loop component.

- B. Power supply and conversion modules shall be supplied as required to provide the required equipment operational voltage and current. Power supplies shall be sized to provide 125 percent of the maximum current requirements.
- C. General Purpose Relays: General purpose relays in the Control Panels shall be plug-in type with contacts rated 10 amperes at 120 volts ac; quantity and type of contacts shall be as indicated. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover with LED status indicator. Sockets for relays shall have screw type terminals.
- D. Industrial Control Relays: Industrial control relays shall be 20 Amp rated with four-pole convertible contacts. The coil voltage shall be as required to interface with the required control logic. The ICR shall be capable of providing eight contacts with the addition of a four-pole module mounted to the deck assembly.
- E. Time Delay Relays: Time delay relays shall be electronic on-delay or off-delay type with contacts rated 10 amperes at 120 volts AC. Units shall include adjustable dials with graduated scales covering the indicated time range. Timers shall be provided with status and timing LED indication.
- F. Slave Relays: Slave relays shall be provided when the number or type of contacts indicated exceeds the contact capacity of the indicated relays and timers.
- G. Circuit Breakers: Circuit breakers shall be single pole, 120-volt, 15 ampere (minimum) rating or as required to protect wiring and equipment. Circuit breakers shall be mounted inside the panels as shown.

PART 3 – EXECUTION

3.1. GENERAL

- A. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all elements, all instruments, all accessories, and all assemblies provided under this Contract.
- B. The CONTRACTOR shall install all instruments according to the manufacturer's installation instructions and provide the following:
 - 1. Perform field engineering as required for mounting and supporting all field mounted components.
 - 2. Prepare any additional schematic and interconnection diagrams required for installation and submit for review prior to installation.
 - 3. Assemble and interconnect instrument components disconnected for shipping purposes.
- C. Remove all temporary supports, bracing, and padding inserted in instrument control panels and other equipment to prevent damage during shipping, storage, or installation
- D. All field equipment installations of conduit, piping, tubing, mounting hardware and equipment enclosures shall be field measured prior to fabrication and erection. Any significant discrepancies between drawings and field conditions shall be reported to the Engineer. The Owner will not be responsible for any costs to the Contractor for rework because of Contractor failure to take measurements prior to fabrication.

3.2. INSTALLATION

A. General

1. The CONTRACTOR shall install and connect all field-mounted components, equipment enclosures and assemblies under the following criteria:
 - a. All power and all signal wires shall be terminated.
 - b. All external connections and penetrations shall be watertight.
 - c. After all installation and connections have been completed, a technical field representative of the systems integrator shall check the work for polarity of electric power and signal connections, leaks at all process connections, and conformance with requirements.
 - d. All wire and all cable shall be connected from terminal to terminal without splices, arranged in a neat manner and securely supported in cable groups. All wiring shall be protected from sharp edges and corners.

B. INSTRUMENT INSTALLATION

1. Install instruments at the location shown on the Plans or approved by the Owner. Instruments shall be NEMA rated for the installed location.
 2. Monitoring and control system configurations are diagrammatic only. Locations of equipment are approximate unless dimensioned on the drawings. The contractor shall determine exact locations and routing of wiring and cables, which shall be governed by structural conditions, physical interferences, area classifications and locations of electrical terminations on equipment.
 3. Install level and plumb.
 4. All instruments shall be provided with floor stands, stanchions or wall brackets as shown and required for operation.
 5. Mounting hardware, stands, channels, and spacers shall be either stainless steel, or non-metallic to match the NEMA rated location.
 6. All screws and bolts shall be stainless steel.
- C. Provide system piping installations in accordance with Owner standards and manufacturer's requirements. All flow thru, tee and insertion instrumentation sensors shall be installed with hot-tap assemblies or valving systems that allow the instrument to be removed from the system without disruption of the process.
- D. All instruments shall be located and installed for ready access by the OWNER'S operation and maintenance staff. Instruments shall be installed with due regard for servicing and maintainability. The OWNER reserves the right to require minor changes in location of equipment prior to roughing without any additional cost to the OWNER.

3.3. SIGNAL AND CONTROL WIRING

- A. All wires contained with a panel shall be routed in plastic wireways except:
1. Field wiring, field wiring within a control panel shall be wired within a dedicated field wireway.
 2. Wiring between mating blocks in adjacent sections

3. Wiring from components on a swing-out panel to components on the fixed structure
 4. Wiring to panel-mounted components.
- B. Wiring from components on a swing-out panel to other components on fixed panels shall be tied into bundles with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals.
- C. Wiring to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using adhesive mounts.
- D. Wiring to rear terminals on panel-mount instruments shall be in plastic wireways secured to horizontal brackets above or below the instruments in and about the same plane as the rear of the instruments.
- E. Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using white numbered wire markers which shall be permanently marked heat-shrink plastic.

3.4. SYSTEM COMMISSIONING

A. Instrument Calibration

1. All analog and discrete instrumentation and all control system equipment shall be field calibrated and tested after installation to verify that requirements are satisfied. The Contractor shall provide all necessary labor, tools, and equipment to calibrate and test each instrument in accordance with the manufacturer's instructions. Each instrument shall be calibrated at a minimum of three points using test equipment to simulate inputs and read outputs.
2. All test equipment and all instruments used to simulate inputs and read outputs shall be suitable for the purpose intended and shall have accuracy better than the required accuracy of the instrument being calibrated. Test equipment shall have accuracies traceable to the NIST as applicable. All analog instruments shall be calibrated and tested in place without removal.
3. Test data, applicable accuracy requirements, all instrument manufacturer published performance specifications and all permissible tolerances at each point of calibration shall be entered on test forms available from the ENGINEER. These test forms shall verify compliance with all.
4. All pressure instruments shall be calibrated with a pressure calibrator. A calibration report shall be delivered to the ENGINEER for each instrument, certifying that the instrument has been calibrated in the presence of the Owners designated representative and meets contract and system requirements.

B. Control Input/Output Point Testing

1. Analog Loop Tests: The CONTRACTOR shall be responsible for loop checking and testing all instrumentation loops with this project. The CONTRACTOR shall coordinate all loop check functions with the SCADA system, final element, PLC logic and intermediate equipment to ensure that a single total loop check is conducted. The intent of the loop checks is to confirm and document each loop's component specification conformance up to and including all field-situated devices.

2. The CONTRACTOR shall provide all control room personnel to witness and confirm loop check results at the SCADA display level.
 3. The CONTRACTOR shall provide all necessary labor, tools, and equipment to field test, inspect and adjust each instrument to its indicated performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirement, or any published manufacturer performance specification for functional and operational parameters, whether or not indicated in the Contract Documents, shall be repaired or replaced, at the discretion of the ENGINEER at no additional cost to the OWNER.
- C. Programmable Controllers, Operator Interface Units, and electronic function modules, shall be tested and exercised by the CONTRACTOR to demonstrate correct operation, first individually and then collectively as functional analog networks. Each hardwired analog control network shall be tested to verify proper performance within indicated accuracy tolerances. Accuracy tolerances for each analog network are defined as the root-mean-square summation of individual component accuracy tolerances. Individual component accuracy tolerances shall be as indicated by contract requirements, or by published manufacturer accuracy specifications, whenever contract accuracy tolerances are not indicated.
1. Each analog process loop/network shall be tested by applying simulated inputs (4 – 20mA) to the first element(s). Simulated sensor inputs corresponding to 10 percent, 50 percent, and 90 percent of span shall be applied, and the resulting outputs read to verify compliance to network accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation of discrete devices.
 2. Temporary settings shall be made on controllers, alarms, etc., during analog loop tests. All analog loop test data shall be recorded on test forms, which include calculated root-mean-square summation system accuracy tolerance requirements for each output.
 3. When installation and loop tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the Owner's representative as a witness, with test data entered, shall be submitted together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, fully inspected, and fully tested.
- D. SYSTEM PRECOMMISSIONING
1. The CONTRACTOR shall responsible for demonstrating the operability of all systems provided under this specification. Pre-commissioning shall commence after acceptance of all wire, all calibrating and loop tests, and all inspections have been conducted. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under actual operating conditions.
 2. The CONTRACTOR shall submit an instrumentation and control system pre-commissioning completion report which shall state that all Contract requirements have been met and which shall include a listing of all instrumentation and all control system maintenance and repair activities conducted during the system commissioning testing.

3.5. OPERATIONS AND MAINTENANCE MANUALS:

- A. The CONTRACTOR shall furnish to the OWNER the specified complete sets of operation and maintenance manuals. The manuals shall include data, information drawings, etc., for the system, subsystem, and all components, and shall include names, addresses and telephone numbers of equipment suppliers, representatives and repair facilities.
- B. This shall include a complete description of the recommended operating procedures, maintenance procedures, and spare/replacement parts list for equipment items with catalog data, diagrams, and drawings or cuts describing the equipment. Each set shall include full size assembly and wiring diagrams; drawings showing "as-built" conditions shall be furnished to the OWNER.

3.6. TRAINING

- A. Instruction: The CONTRACTOR shall train the OWNER'S maintenance personnel in the maintenance, calibration and repair of all instruments provided under this contract.
- B. The training shall be scheduled a minimum of 3 weeks in advance of the first session. The training shall be performed concurrent with the precommissioning.
- C. The training shall be performed by qualified representatives of the instrument manufacturers and shall be specific to each instrument model provided. Instructors shall have at least 2 years of training experience.
- D. Each training class shall be a minimum of 4 hours in duration and shall cover Operational Theory, Maintenance, Trouble Shooting/Repair, and Calibration of the instrument and equipment.
- E. Proposed training material, including resumes for the proposed instructors and a detailed outline of each lesson shall be submitted to the ENGINEER at least 30 days in advance of when the lesson is to be given. The ENGINEER shall review the submitted data for suitability and provide comments that shall be incorporated into the course.

END OF SECTION

SECTION 467600 – RESIDUALS DEWATERING EQUIPMENT

PART 1 – GENERAL

1.1. SCOPE

- A. CONTRACTOR shall furnish and install one (1) integrated screw press sludge dewatering system as indicated on the drawings. The screw press shall be manufactured from AISI 304L stainless steel shapes. Fabrication and assembly shall be in conformance with these specifications and drawings.
- B. CONTRACTOR shall furnish a complete dewatering system including screw press, drive motors, gear reducers, support legs, anchor bolts, controls, sludge feed pump, polymer activation and feed system, and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.
- C. CONTRACTOR shall coordinate all details of the equipment with other related parts of the work. He shall verify that all structures, piping, wiring, and equipment components are compatible. CONTRACTOR shall be responsible for all structural and other alterations required to accommodate equipment differing in dimensions or other characteristics from these specifications and drawings.
- D. CONTRACTOR shall install the equipment according to instructions and recommendations of the equipment manufacturer.

1.2. REFERENCES

- A. American Society for Testing and Materials (ASTM) Publications:
 - 1. Section A322: Carbon and Alloy Steel Bar Specifications.
 - 2. Section A507-10: Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold Rolled
- B. Anti-Friction Bearing Manufacturers Association (AFBMA) Publications:
 - 1. Standard 9-90 Load Ratings and Fatigue Life for Ball Bearings.
 - 2. Standard 11-90 Load Ratings and Fatigue Life for Roller Bearings.
- C. American Institute of Steel Construction (AISC) Publications
- D. American Welding Society (AWS) Publications
- E. American Structures Painting Council (ASPC) Publications

1.3. SUBMITTALS

The following information shall be submitted to the ENGINEER. In accordance with Section 013323, copies of all materials required to establish compliance with this Section. Submittals shall include the following:

- A. Product Data: Include the following:
 - 1. Descriptive literature, brochures, catalogs, cut-sheets and other detailed descriptive material of the equipment.
 - 2. Motor characteristics and performance information.

3. Gear reducer data including service factor, efficiency, torque rating, and materials.
4. Parts list including a list of recommended spare parts.
- B. Shop Drawings: Include the following:
 1. Manufacturer's installation drawings.
 2. Wiring and schematic diagrams.
- C. Operations and maintenance manual: See Section 013323.
- D. Detailed installation instructions, with clear step-by-step points on the correct mechanical and electrical installation procedures.
- E. Equipment weights and lifting points.
- F. Recommendations for short- and long-term storage.
- G. A copy of the manufacturer's warranty.
- H. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001 and Environmental Protection Management System according to ISO 14001.
- I. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

1.4. QUALITY ASSURANCE

- A. To ensure quality, conformance, and reliability with regard to the manufacturing and production of the machinery described in this section, the equipment manufacturer shall meet the requirements listed in this section
- B. Manufacturer shall have established an ISO 9001 certified quality management system.
- C. Manufacturer shall have established an ISO 14001 certified environmental protection management system.
- D. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. No stainless-steel components may be fabricated or assembled in a factory where carbon steel products are also fabricated, in order to prevent contamination by rust.
- E. Screw Press shall be manufacturer's standard product and only be modified as necessary to comply with the drawings, specifications, and specified service conditions.
- F. All welding is performed in accordance with American Welding Society (AWS) D1.1 Structural Welding Code, or equivalent.
- G. Manufacturer shall provide screw press, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.
- H. Manufacturer shall provide services by a factory-trained service engineer, specifically trained on the type of equipment specified. Service engineer requirements include, but are not limited to the following:

1. Service engineer shall be present during initial energizing of equipment to determine directional testing as described in Section 4.01 C (Installation).
 2. Service engineer shall inspect and verify location of anchor bolts, placement, leveling, alignment and field erection of equipment, as well as control panel operation and electrical connections.
 3. Service engineer shall provide classroom and/or field training on the operation and maintenance of the equipment to operator personnel.
 4. Manufacturer shall state field service rates for a service engineer to OWNER and CONTRACTOR. In the event that the field service time required by this section should not be sufficient to properly place the equipment into operation, additional time shall be purchased by CONTRACTOR to correct deficiencies in installation, equipment, or material without additional cost to OWNER.
- I. CONTRACTOR shall guarantee all equipment against faulty or inadequate design, improper assembly or installation, defective workmanship or materials, and breakage or other failure. Materials shall be suitable for service conditions.
 - J. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service prior to delivery, except as required by testing.
 - K. Each major component of equipment shall have the manufacturer's name, address and product identification on a nameplate securely affixed to the equipment.
- 1.5. DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT
- A. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.
 - B. CONTRACTOR shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.

PART 2 – PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

- A. Sludge Dewatering System:
 1. Huber Technology, Inc. Model Q-Press 440.2
 2. Engineer pre-approved equivalent
- B. Liquid polymer blending system:
 1. Model M240-P2-AB by UGSI
 2. Engineer pre-approved equivalent
- C. Sludge feed pump:
 1. Seepex Series BN

2. Engineer pre-approved equivalent
- D. Dewatered Cake Conveyor:
1. Huber Model Ro8t
 2. Engineer pre-approved equivalent
- E. Alternates shall not be acceptable unless they have been pre-approved. Manufacturers of alternative equipment shall submit a pre-approval package to the engineer within two (2) weeks after bid date. Alternative manufacturers shall submit the following information and supporting documentation:
1. List of at least ten (10) operating installations with more than two years of continuous service with reference contacts.
 2. A complete set of drawings, specifications, catalog cut sheets, and detailed descriptive material. Drawings shall show all relevant details of the unit. This information shall identify all technical and performance requirements stipulated on the drawings and in the specification. If the proposed equipment does not meet these specifications, any deviation from the specification must be expressly noted. All deviations shall be listed on a single, exceptions-requested document.
 3. Detailed installation drawings illustrating how the proposed screw press will be installed. The drawings shall include plan, elevation, and sectional views of the installation including coordination with all support utilities and structures.
 4. Flocculation device drawings shall include details of the injection ring, mixing valve, flocculation reactor, and details of the anchor bolt locations.
 5. Motor characteristics and performance information for all motors proposed. Vendor data shall be furnished to confirm the torque and thrust rating of the drive.
 6. Complete reference list of all installations of same and similar equipment including contact names and phone numbers, showing at least 15 installations of the same type and size as specified.
 7. Complete bill of materials for all equipment, showing dimensions and materials of construction of all components.
 8. Certification by the manufacturer that all stainless steel equipment will be manufactured in a stainless steel only factory.
 9. Certification that the entire screw press equipment will be passivated by submersion in an acid bath as specified herein.
 10. Certificates documenting the Manufacturer's ISO 9001 Quality Management System and ISO 14001 Environmental Protection Management System.
 11. Complete details of the control and instrumentation system including wiring diagrams.
 12. Information on equipment field erection requirements including total weight of assembled components and weight of each sub assembly.
 13. List of all recommended spare parts.

14. A maintenance schedule showing the required maintenance, frequency of maintenance, lubricants and other items required at each regular preventative maintenance period, including all buy out items.

2.2. PERFORMANCE AND DESIGN REQUIREMENTS

- A. Sludge to be dewatered shall be well-mixed and well blended having the following characteristics:
1. Sludge: WAS
 - a. Treatment Process: Oxidation Ditch with Sludge Storage Tank
 - b. Solids concentration: 0.8-1.8%
 - c. Volatile solids: 83-87%
 - d. Other sludge characteristics:
 - (i) pH 6.6-6.9
 - (ii) Alkalinity $\geq 1,000$ mg/L as CaCO_3
 - (iii) TDS 500-600 mg/L
 - (iv) Phosphate 50 mg/L
 - (v) Chloride 45-60 mg/L
- B. Each dewatering screw press shall be capable of dewatering the specified municipal wastewater sludge to a final solids content of 13-14%. The solids capture rate shall be a minimum of 95%. The polymer consumption shall not exceed 25 lbs. of active polymer substance per ton of sludge solids fed. The above performance requirements are based on results laboratory testing conducted. If sludge characteristics change from the indicated values, subsequent laboratory testing shall be conducted to determine appropriate revisions to the performance requirements. All testing shall be confirmed by a third-party laboratory chosen by the OWNER. Contractor shall pay for all necessary testing.
- C. Volumetric capacity of the screw press shall depend on feed solids concentrations according to the following table:

Feed Solids Concentration	Screw Press Capacity
0.8%	32 gpm
1.2%	25 gpm
1.8%	18 gpm

- D. The sludge dewatering plant consists of the following major parts:
- a. Screw Press including support legs as described in section 2.03
 - b. Polymer dosing system as described in section 2.07
 - c. Sludge Feed Pump as described in section 2.08
 - d. Dewatered Cake Conveyor as described in section 2.09
 - e. Control panel as described in section 2.10

- E. All parts of the dewatering press shall be designed and appropriate for the service specified and indicated and for continuous operation.
- F. Sufficient room for inspection, maintenance, repair and adjustment shall be provided. CONTRACTOR shall provide hoisting equipment to facilitate installation and maintenance work.
- G. The physical layout shown on the drawings is based on the Huber Q-Press 440.2. If equipment by another manufacturer is to be supplied, CONTRACTOR shall include in the bid all necessary modifications to the piping, electrical, structural, and mechanical layouts to accommodate the equipment proposed. CONTRACTOR shall pay ENGINEER for all modifications of drawings.
- H. All parts shall be designed and manufactured to handle the forces that may be exerted on the screw press during fabrication, shipping, erection, and proper operation according to the O&M manual.
- I. All components shall be so arranged that they can be serviced from the operating floor.
- J. All components shall be balanced so that jamming at any point will not result in structural failure, but will cause the drive motor to stall. All components, including the gear reducer, shall be designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor.

2.3. SLUDGE DEWATERING PRESS DESIGN SPECIFICATIONS

A. MATERIALS

- 1. Sludge dewatering press shall be manufactured from AISI 304L stainless steel shapes (rods, angles, and channels), pipes, and sheets. In particular, wedge wire basket, screw, shaft, covers; support legs, fasteners and anchor bolts shall be made of this material.
- 2. Wipers for helical screw flights shall be of wear resistant polyurethane (PU) material. Wipers must have a basket contact width of at least .315 in (8 mm). The wiper shall be held in place by stainless steel clamps and set screws which can be easily removed. The wiper shall have a self-contained a dampening mechanism to maintain constant contact with the basket while limiting wear. Wiper self-contained dampening mechanism shall compensate for up to 4mm of radial wiper wear. Brushes or wipers without this functionality shall not be accepted.

B. DESIGN

- 1. The screw press shall be installed inclined (at 15°). Dewatering of the sludge must occur in a fabricated screening basket consisting of three sections of wedge wire baskets. The overall basket length shall be 86 in (2,250 mm). The basket diameter shall be 17 in (440 mm).
- 2. The screw press shall be completely enclosed to prevent odor emission. The whole dewatering section and basket area shall be easily accessible through an inspection lid, which shall be mounted via two hinges on the side of the machine.

3. A screw shall be installed inside of the screen basket. The screw transports the sludge from the inlet to the discharge area at the end of the pressure zone. Its shaft diameter shall be conical towards the discharge section of the machine. The flights of the helical screw shall be provided with replaceable brushes to clean the wedge wire screen from the inside.
4. The screw shall be shafted and shall be made of stainless steel. A shaft-less screw is not acceptable. A bearing shall support the discharge end of the screw shaft. Wear strips are not acceptable.
5. Each section of the wedge wire basket shall be split in half along the length of the basket to allow for easy separation of the basket into halves for servicing of the wiper. The basket shall be fastened together using bolt fasteners made of stainless steel. The screw press shall be provided with alignment pins for ease of basket alignment during reassembly. Designs which require the entire basket to be removed from the machine for servicing the wiper will not be accepted.
6. A screw drive shall be provided at the sludge feed side of the press. The nominal motor power shall be 2.0 HP. The motor speed shall be controlled with a VFD. The drive unit shall be directly coupled to the screw shaft through a gearbox.
7. The cleaning of the wedge wire screen from the outside shall be performed with a stationary spray bar washing system made of stainless-steel piping and spray nozzles. The spray area shall run the entire length of the screen. One solenoid valve shall control the flow to the spray bar washing system. If a cleaning cycle is initiated, the screw press motor reverses and rotates the basket, until has completed a 360-degree rotation ensuring the entire surface area of the screen is cleaned. CONTRACTOR shall provide 1 in female threaded connection for the water supply piping to the manifold of the spray system.
8. Spray water supply shall be designed for a minimum flow of 28 GPM (can be filtered non-potable water, allowed particle size 500 microns at maximum 200 ppm) at a minimum pressure of 70 PSI. Water pressure at each nozzle of the spray bar shall be a minimum of 70 PSIG. Average spray water consumption shall not exceed 21 Gallons at 70 PSIG per wash cycle. The basket shall rotate with maximum speed as mentioned in section 2.05 below.
9. A pneumatically actuated cone that serves for adjusting the pressure in the pressure zone shall be provided at the discharge end of the screening basket. The pressurized air supply shall be provided by the CONTRACTOR.
10. Sludge cake shall be automatically discharged through a rectangular sludge discharge opening. The discharge height shall be minimum 37.5 in above floor level.
11. CONTRACTOR shall provide a 4 in diameter drain line for the filtrate and connect it to the bottom drain connection of the screw press. The drain line shall also be provided with a 1.5 in flush connection with manual ball valve.

2.4. INTERNAL PIPING

- A. CONTRACTOR shall provide and install a sludge feed pump. The sludge feed pump shall be of the progressive cavity type. The pump shall be controlled through a variable frequency controller (VFD) which shall accepting a pacing signal from the screw press control panel, supplied by the manufacturer of the screw press.
- B. CONTRACTOR shall provide sludge feed pipe from the sludge feed pump (with VFD) through a magnetic-inductive flow meter through a polymer-dosing ring, polymer mixing valve.
- C. Polymer dosing ring and polymer mixing valve shall be supplied by the screw press manufacturer.
- D. Pipe flocculator to be supplied by the CONTRACTOR and shall provide a minimum retention time of 45 seconds at design flow for the polymer and sludge mixture.
- E. The design of the flocculation pipe reactor shall be approved by the screw press manufacturer.
- F. The size of the piping needs to take into account: maximum capacity, loading rate, minimum velocity in piping to avoid sedimentation and conditions which do not negatively impact the flocculation process.

2.5. DRIVE

- A. The press screw shall be driven by a shaft mounted gearbox and motor assembly. The gear reducer shall be bolted to a machined flange welded to the lower end of the press.
- B. The gear reducer shall be driven by a 1,680 rpm, 3-phase, 60 Hertz, 230/460 volt, continuous-duty motor with a conduit box suitable for outdoor operation. The motor power shall be 2.0 hp.
- C. The output speed of the gear reducer shall be 1.3 rpm at frequency of 60 Hz.
- D. Chain-drives, belt drives, hydraulic drives or a separate upper bearing for the transport screw will not be acceptable for this project.

2.6. AIR COMPRESSOR

- A. Provide one (1) portable air compressor as manufactured by Porter Cable, model C2002.
- B. Air compressor shall use an UMC type motor rated for 0.8 Hp, 12,600 RPM, 115 V, 10 Amps.
- C. Shall have a NPT outlet of 1/4 in.
- D. Tank shall be 6 gallons.

2.7. POLYMER DOSING SYSTEM FOR LIQUID POLYMER

A. SYSTEM DESCRIPTION

1. Multi-Zone Mixing Chamber

- a. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy.
 - (i) High shear zone of the mixing chamber shall have a mechanical mixing impeller for successful initial activation and the low shear zone shall not have a mixing impeller to avoid damaging polymer molecules.
 - (ii) Solution shall undergo a tapered mixing intensity slope as it exits the initial high sheer zone and passes through a second low shear zone, isolated by a baffle.

- (iii) The design shall have primary mixing and post-dilution to maximize the value of breaker surfactant present in emulsion polymer, as per the AWWA Standard for Polyacrylamide (ANSI/AWWA B453-06).
 - (iv) Polymer activation efficiency shall be consistent over the dilution water range.
 - b. Mixing chamber shall be transparent to allow viewing of mixing intensity. Opaque mixing chambers shall be unacceptable.
 - c. Impeller shall be driven by a ½ HP maximum washdown duty motor.
 - (i) Motor shall be TEFC.
 - (ii) Impeller speed shall be 3450 rpm, minimum.
 - (iii) Motor shall be direct-coupled to impeller shaft.
 - d. Mixing chamber shall include a stainless-steel injection check valve.
 - e. In order to quantify the mixing intensity in the mix chamber, the applied horsepower shall be defined by measuring the difference in torque when the mix chamber is empty versus being full of water. This value shall be the basis of determining the mixing intensity defined as "G" value.
 - f. The G-value in the high shear mixing zone shall exceed 14,000 sec⁻¹ to effectively disperse polymer gels to prevent fisheye formation.
 - g. The G-value in the low shear mixing zone shall be lowered to 3,500 sec⁻¹ to avoid damaging polymer chains.
- 2. Dilution Water Control
 - a. Dilution water shall be split into two streams.
 - (i) Primary water flow shall supply the mixing chamber.
 - (ii) Secondary water flow shall be used to post dilute the activated polymer stream.
 - (iii) These two streams shall be completely blended by a static mixer prior to exiting the unit.
 - b. Unit shall have an electric solenoid valve for on/off control of total dilution water flow.
 - c. Flow indicators and flow control valves shall be provided for each dilution water stream.
 - d. Dilution water and solution output connections shall include 304 stainless steel unions connected to the chassis.
- 3. Pump
 - a. Unit shall have a neat polymer metering pump.
 - (i) Pump shall be positive displacement, progressing cavity type.

- (ii) Rotor shall be 316 stainless steel
- (iii) Stator shall be Viton.
- (iv) Pump shall have mechanical seal.
- b. Pump shall be driven by a ½ HP, AC motor.
 - (i) Variable speed shall be provided by a VFD controller.
 - (ii) Motor shall be washdown, TENV duty.
 - (iii) Motor shall be direct-coupled to a gear reducer.
 - (iv) Pump shall be direct-coupled to gear reducer.

4. Controls

- a. Unit shall be powered through an on-off-remote circuit controlled by a three-position switch.
 - (i) In the remote switch position, the unit shall accept a run signal.
 - (ii) Unit is manually powered in the on position.
- b. Unit shall accept a 4-20 mA analog signal to pace the polymer metering pump.
 - (i) This signal shall drive the controller when in the auto mode.
 - (ii) The controller shall also have manual motor speed control via a potentiometer for SCR or touchpad for VFD.
- c. Unit shall detect loss of water flow, sensing that water flow has been interrupted for any reason, will place the polymer pump and mix chamber on standby and will restart it automatically when flow is restored.
- d. An integral timer shall monitor loss of flow and energize contacts indicating alarm after 15 seconds of continuous loss.

B. TECHNICAL DATA

- 1. Connections – Plumbing
 - a. Dilution water inlet, 3/4" FNPT
 - b. Neat polymer inlet, ½" FNPT
 - c. Solution discharge, 3/4" FNPT
- 2. Connections – Electrical
 - a. Standard, grounded male plug – 120 / 1 / 60, 17 amps
 - b. Terminal blocks – 4-20 mA signal input
 - c. Terminal blocks – dry contact input for remote start
 - d. Terminal blocks – dry contact alarm output
 - e. Terminal blocks – dry contact run output

3. Dimensions
 - a. Frame – 37” wide x 28” deep x 47” high (94 x 71 x 120 cm)
 4. Materials of Construction
 - a. Structural frame – 304 stainless steel
 - b. Plumbing – PVC, nylon, stainless steel
 - c. Mixing chamber – PVC, acrylic
 5. Performance
 - a. Dilution water – 120-120 GPH primary mixing (45-454 LPH)
12-120 GPH post dilution (45-454 LPH)
 - b. Metering pump – 0.1-2 GPH neat polymer (0.4-7.6 LPH)
 - C. INSTALLATION
 1. The equipment shall be installed per the contract documents and manufacturer’s recommendations.
 - D. WARRANTY
 1. The standard warranty extends for a period of twelve (12) months from the date of start-up by an authorized UGSI technician or eighteen (18) months from the date of shipment, whichever occurs first.
 2. Damage due to makeup water particulates will not be considered as a warranty defect and will be the responsibility of the OWNER.
- 2.8. SLUDGE FEED PUMP
- A. ACCEPTABLE PRODUCTS
 1. Progressing cavity pumps shall be Seepex Series BN, or approved equal.
 2. CONTRACTOR is responsible for all costs incurred by the County associated with review and approval of proposed alternate manufacturer’s residual dewatering equipment.
 - B. MATERIALS

Component	Material - Sludge Pumps
Pump Manufacturer	Seepex or approved equal
Pump Type	Progressive Cavity
Flow Rate	~20 gpm
Suction Lift	Approximately 7.25 psi (max)
Discharge Pressure	35 psi
Pump HP	5 HP (Premium Efficiency Motor)
Drive Type	VFD
Inlet size and connection requirements	3" ANSI 150# (Max)
Outlet size and connection requirements	2.5" ANSI 150# (Max)
Rotor	316ss - Duktal Coated (1250 Vickers hardness)
Stator	Buna N
Pump Body	Cast iron
Shaft Sealing	Burgmann MG1 Q1Q1VGG Or Packing

C. EQUIPMENT

1. ROTOR AND STATOR: Each pump shall be a one stage design employing a convoluted rotor operating in a similarly convoluted stator. The convolutions shall be configured to form a cavity between the rotor and stator, which shall progress from the pump's inlet to discharge port with the operation of the rotor. The fit between the rotor and stator at the point of contact shall compress the stator material sufficiently to form a seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber. The stator shall be molded with a seal integral to the stator elastomer preventing the metal stator tube and the bonding agent from the elastomer from contacting the pumped liquid. Gaskets or "O" rings may not be used to form this seal. Stators for sludge pumps shall have Buna elastomer. The sludge pump rotors shall be constructed of 316 SS. Additionally, the sludge pump rotors shall have a chromium nitride coating (Duktal) with a hardness of 1250 Vickers and a minimum thickness of (.0108"). Hard chrome plating or ceramic coatings are not acceptable due to the ease at which this coating will crack and the lack of diffusion into the rotor base metal.
2. ROTOR AND DRIVE TRAIN: The rotor drive train shall be warranted for three (3) years from acceptance and shall consist of the following:

- a. Each pump rotor shall be driven through a positively sealed and lubricated pin joint. The pin joint shall have replaceable bushings, constructed of air-hardened tool steel of 57-60 HRC, in the rotor head and coupling rod. The pin shall be constructed of high-speed steel, air hardened to 60-65 HRC. The joint shall be grease lubricated with a high temperature (450-deg F), PTFE filled synthetic grease, covered with Buna N sleeve and positively sealed with hose clamps constructed of 304 stainless steel. A stainless-steel shell shall cover the rotor side universal joint assembly to protect the elastomer sleeve from being damaged by tramp metals or glass. The universal joints shall carry a separate warranty of 10,000 operating hours. This warranty shall be unconditional in regard to damage or wear.
 3. CASING: A 150-pound (ANSI B16.5) flanged connection shall be provided at both the inlet and discharge ports. The suction and discharge casings shall each be provided with a 3/8-inch (or larger) tap to permit installation of pressure instruments.
 4. BEARINGS: Each pump shall be provided with oil lubricated thrust and radial bearings, located in the gearmotor, designed for all loads imposed by the specified service.
 5. SHAFT SEALING: Shaft shall be sealed using a single internal mechanical seal as specified in Section 2.02. The shaft shall be solid through the sealing area, but of a two-part design which allows the rotating unit to be removed from the pump without disassembly of the gearmotor bearings. Seal materials shall be solid silicon carbide faces with 316 stainless steel metal parts and Viton elastomers.
OR
 6. SHAFT SEALING: Shaft shall be sealed using packing. The shaft shall be solid through the packing area, but of a two-part design which allows the rotating unit to be removed from the pump without disassembly of the gearmotor bearings. If packing is provided, the drive shaft shall be also plated with the same chromium-nitride coating referenced for the rotor in Section 2.03.A, above. Thickness shall be a minimum of 0.010".
 7. MOTOR AND DRIVE UNIT
 - a. Gear motors or gear reducers shall be designed in accordance with AGMA 6019-E (Class II). Unless otherwise noted, motors shall be energy-efficient, TEFC motors.
 - b. Pumps that require adjustable speed drives (ASDs) are noted in paragraph 1.01 E. ASDs shall be constant torque type. For ASD-driven units, the pump supplier shall be responsible for the provision of the fixed reduction between the motor and pump. The reduction ratio shall be that required to operate the pump at its maximum operating speed when the motor is operating at its nominal rated full speed. ASD-driven units may be operated at up to 90 Hz at the maximum speed.
- D. ACCESSORIES:
1. RUN DRY PROTECTION: The stator shall be fitted with a sensor sleeve and thermistor sensor. A controller shall also be provided and shall be installed by the CONTRACTOR in the motor control center. The controller shall monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller. The controller shall include a manual local and remote reset function. Input to the controller shall be 1x115VAC/60 Hz.

2. OVER PRESSURE PROTECTION: Each pump unit shall be supplied with a silicone-filled isolation ring with a dual mounted gauge and single point pressure switch. The pressure ranges for the switch and gauge shall be selected specifically for each specified service. The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans, and be constructed with a carbon steel body and fittings with a Buna sleeve. The switch shall be SPDT, NEMA 4.

E. STANDBY COMPONENTS

1. One set of special tools shall be provided to service the pumps. In addition, the following shall be provided for each pump size (as appropriate for type of drive provided):
 - 1 – stator assembly with TSE sensor sleeve
 - 1 – rotor
 - 1 – set universal joint assemblies

F. INSTALLATION

1. The pumps shall be installed as specified and in accordance with manufacturer's written recommendations.

G. TESTING

1. After completion of installation, the pumps shall be completely tested to demonstrate compliance with operating requirements as specified.

2.9. CAKE CONVEYOR

A. Screw Conveyor Design Summary

- | | |
|----------------------------------------------|-------------------------------------------------------|
| 1. Model: | Ro8t/273 from Huber Technology
(or approved equal) |
| 2. Number: | 1 |
| 3. Min Capacity (each), CF/hr: | 70 |
| 4. Approximate length, ft: | 23 |
| 5. Min. flight outside screw diameter, inch: | 9-9/16-in (243mm) |
| 6. Shaft diameter, inch: | 3-1/2-in (89mm) |
| 7. Installation angle, maximum: | 35° |
| 8. Location of drives: | pulling |

- B. The screw conveyor shall be designed to handle the maximum load as specified above.
- C. The screw conveyor shall be capable of processing spherical objects with a diameter of 3-1/8". Such objects shall be conveyed through the auger and shall be discharged with the dewatered sludge.
- D. Operation of the screw conveyor shall be automatically initiated when a call to run signal is received. The dewatered sludge shall be transported up the screw conveyor and shall be discharged into low-profile, 15-20-CY rolloff dumpster.
- E. To minimize odors and nuisance, the conveyance shall be completely enclosed.

- F. The control system shall be designed such that the operating characteristics of the screw conveyor can be changed via the programmable controller. Systems which do not offer this feature will not be acceptable for this project.
- G. Screw Conveyor Materials
 - 1. Unless otherwise specified in these specifications, the entire equipment shall be manufactured from AISI 304L austenitic stainless-steel shapes (rods, angles, and channels), pipes, and sheets. All mechanical parts shall be designed to handle the forces that may be exerted on the unit during fabrication, shipping, erection, and proper operation according to the O&M manual.
 - 2. The entire equipment shall be manufactured in a stainless steel only factory to prevent contamination of the stainless steel with rusty dust.
 - 3. The equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection.
- H. Screw Conveyor Design
 - 1. The spiral shall have a center shaft. Minimum flight thickness shall be 3/16 inch (5 mm). The spiral flight shall have sufficient stability to prevent distortion and jumping in the trough.
- I. Screw Conveyor Trough Design
 - 1. Each conveyor trough shall be U-shaped, fabricated from a minimum thickness of 1/8" (3 mm) AISI 304L stainless steel plate. Each trough shall be equipped with inlet and discharge connections, as indicated on the drawings. The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging.
 - 2. The entire length of the screw conveyor, with the exception of the filling chute, shall be covered by a bolted cover. Covers shall be manufactured from a material thickness of 5/64" (2 mm) AISI 304L stainless steel plate. The covers shall be manufactured in sections with a maximum of 5-foot lengths to allow for easy access.
 - 3. A wear liner shall be provided for the trough. The wear liner shall be made of a minimum 5/16 inch (8 mm) thick ultra-high-molecular-weight polyethylene. The wear liners shall be manufactured in sections with a maximum length of 39 inches to allow for easy replacement.
- J. Screw Conveyor Supports Design

1. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the Drawings and as required by the supplier's design. The supports shall be shop fabricated from structural AISI 304L stainless steel shapes and plates. At a minimum, each screw conveyor trough shall have supports at the drive end and other end of the trough plus intermediate supports at a maximum of 9-ft foot intervals.
 2. The supports shall be designed to resist 120-mph wind loads on the conveyor perpendicular to the shaft.
 3. The supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.
 4. Provide detailed structural analyses of proposed support systems signed by a California-licensed structural engineer.
- K. Screw Conveyor Drive Design
1. The screw conveyor mechanism shall be driven by a shaft mounted gearbox and motor assembly. The gear reducer shall be bolted to a machined flange welded to the upper end of the conveyor trough.
 2. The gear reducer shall be driven by a 1,760 rpm, 3-phase, 60 Hertz, 230/460 volt, continuous-duty motor with a conduit box suitable for outdoor operation. Motor power shall be 1.5-2.0-hp.
 3. Chain-drives, belt drives, hydraulic drives or a separate upper bearing for the transport screw will not be acceptable for this project.
- L. Screw Conveyor Anchor Bolts
1. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts, hex nuts, and washers shall be stainless steel. Anchor bolts shall be wedge or epoxy type.
 2. Anchor bolts shall be set by the CONTRACTOR. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.10. CONTROLS AND INSTRUMENTATION

- A. The entire control system shall be provided by the Manufacturer of the Screw Press. In addition to the primary, local control panel installed adjacent to the screw press, a redundant OIT shall be installed in the existing MCC/Electrical Room to allow remote monitoring and control of the full dewatering process remotely.
- B. The CONTRACTOR shall provide wiring between all system components as required.
- C. The CONTRACTOR shall provide separate power supplies as follows:
 1. 460 V, 60 Hz, 3 phase power supply to the main control panel
 2. 120 V, 60 Hz, single phase power supply to the polymer system.
 3. 120 V, 60 Hz, single phase power supply to the air compressor.
- D. The dewatering system shall be full-automatic and shall include the following:
 1. Main control panel for screw press

2. Magnetic-inductive flow meters
 - a. WAS feed line
 - b. Polymer solution feed line
3. Automatic control for the pneumatic pressure cone
- E. A 460-volt main control panel shall be provided in a NEMA 4X rated stainless steel enclosure. The enclosure shall be suitable for uni-strut mounting, shall have hinged solar covers which swing horizontally and shall be held closed with 3-Point Latch, and shall include the following:
 1. Main power disconnect switch (pad-lockable)
 2. Control power transformer
 3. Surge arrester
 4. Air conditioning with water washable polyester filters that can be removed for service without opening the panel
 5. H-O-A control switches (screw drive including F/R selector switch, thin sludge pump, wash water solenoid valve)
 6. 2.0 hp Allen-Bradley PowerFlex 525 VFD, with Ethernet, shall be provided to control the screw press main drive. (VFD for Sludge Feed Pump NOT included).
 7. Maximum 1.5 hp non-reversing motor starter including over-current and over-heat protection for the cake discharge conveyor.
 8. Programmable logic controller (PLC) Allen Bradley CompactLogix 5069-L306ER with on-board Ethernet.
 9. Operator Interface (OIU), Allen-Bradley PanelView Plus 7 with color touch screen and Ethernet communication.
 10. Running time meter for screw press, conveyor and sludge feed pump
 11. Text messages displayed on touch screen:
 - a. Over-current indications
 - b. Spray bar washing system on
 - c. Polymer dosing station status
 12. Operating and warning lights for the following:
 - a. Power on
 - b. Dewatering system in operation
 - c. Malfunction indication
 - d. Reset button
 13. Laminated plastic nametags shall be provided for the name of the control panel and all disconnects, switches, lights, and meters.
 14. Terminal connections for interfacing with remote systems, shall include the following:
 - a. Remote Polymer Injection System:

- (i) Inputs to Dewatering Control Panel:
 - (1) Dry 120VAC Rated, 2 amp Minimum
 - Polymer System in Remote
 - Polymer System Running
 - Polymer System Common Fault
 - (ii) Outputs from Dewatering Control Panel:
 - (1) Dry 120VAC Rated, 2 amp Minimum
 - Polymer System Call to Run
 - (2) 4 – 20 mA Analog Output
 - Polymer Pacing Signal
- b. Remote Sludge Feed Pump VFD:
- (i) Inputs to Dewatering Control Panel:
 - (1) Dry 120VAC Rated, 2 amp Minimum
 - Sludge Pump in Remote
 - Sludge Pump Running
 - Sludge Pump Common Fault
 - (ii) Outputs from Dewatering Control Panel:
 - (1) Dry 120VAC Rated, 2 amp Minimum
 - Sludge Pump Call to Run
 - (2) 4 – 20 mA Analog Output
 - Sludge Pump Pacing Signal
- c. SCADA Status:
- (i) Inputs to Dewatering Control Panel:
 - (1) Dry 120VAC Rated, 2 amp Minimum
 - Remote Dewatering System Start Command
 - (ii) Outputs from Dewatering Control Panel:
 - (1) Dry 120VAC Rated, 2 amp Minimum
 - Press Running
 - Press Fault
 - Dewatering Mode
 - System Disturbance

PART 3 – EXECUTION

3.1. INSTALLATION, START-UP AND OPERATOR TRAINING

- A. CONTRACTOR shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. CONTRACTOR shall confirm availability and suitability of existing underground conduits for power and control as noted in the drawings. CONTRACTOR shall notify ENGINEER of significant deviations.

- B. Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the manufacturer's recommendations.
- C. After Installation touch-up paint shall be applied to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting. CONTRACTOR shall passivate all field welds.
- D. Supplier shall furnish the services of a factory-trained service engineer for two (2) trips including a total of six (6) workdays to inspect the installation, observe start up, and provide operator training.
 - 1. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the service engineer present.
 - 2. The service engineer shall make all necessary adjustments and settings to the controls.
 - 3. The service engineer shall demonstrate proper and sequential operation of the dewatering system. The dewatering system shall be able to operate fully automatically.

3.2. WARRANTY

- A. The manufacturer will warrant against any defects in material or workmanship to the screw press and framework. This warranty will commence upon delivery of the products and will expire on the earlier to occur of one (1) year from initial operation of the product or 18 months from delivery thereof (the "Warranty Period").

END OF SECTION