06 TECHNICAL SPECIFICATIONS

MESA LIFT STATION UPGRADE (CIP WW-11)

Section # of Pages

SECTION 00020 – TECHNICAL SPECIFICATIONS TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

DIVISION 1 – GENERAL REQUIREMENTS

DIVISION 2 – SITEWORK

DIVISION 3 – CONCRETE

DIVISION 5 – METALS

DIVISION 6 – WOOD, PLASTICS AND COMPOSITES

NOT USED

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

DIVISION 8 – OPENINGS

NOT USED

SECTION 011000 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Construction Documents
4. Phased construction
5. Lift station operation during construction
6. Construction and schedule constraints
7. Phased construction
8. Sequence of construction
9. Access to site.
10. Coordination with occupants.
11. Work restrictions.
12. Specification and drawing conventions.
13. Miscellaneous provisions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: **City of Beaumont, Mesa Lift Station Upgrade**

1. Project Location: Potrero Blvd, City of Beaumont, California

B. Owner: City of Beaumont

C. Engineers: Albert A. Webb Associates, Brad Sackett (951) 686-1070

Aqua Engineering, Justin Logan (801) 299-1327

1. Engineers have been engaged for this Project to provide engineering services.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The following list has been furnished for the convenience of the Contractor and shall not be considered as representing all Work required in the Contract Documents. Contractor shall not take advantage of any errors or omissions in this listing and shall report any discrepancies or questionable items to the Engineer for clarification. The Work of Project is defined by the Contract Documents and consists of the following:

1. The Mobilization of all equipment, labor, tools, and materials to and from the project site.

2. Site demolition and removal of existing equipment and/or infrastructure as indicated in the Contract Documents.

3. Construction of a new grinder manhole and installation of a new grinder.

4. Replacement of existing pumps, valves, discharge, and suction piping as noted in the Contract Documents.

5. Construction of a new concrete emergency storage basin and installation of basin cover.

6. Modification of electrical gear as noted in the Contract Documents.

7. Modifications of existing odor control system equipment per manufacturer's recommendations. **The contractor shall engage the odor control system manufacturer to provide the required services to modify the existing system. Please refer to Technical Specifications Appendix K for vendor information and regarding the specific required activities. Note that it is the contractor's responsibility to verify the cost of the recommended services at the time of the bid.**

8. **Installation of a new Post-Tensioned "Proto-II" CMU wall. (Please refer to Technical Specifications Appendix L included herein for Proto-II wall system design and installation requirements.) Proto-II CMU wall shall be installed by a certified installer. Installers certification shall be included with a complete wall system submittal.**

9. Replacement of the gate operator and chain.

10. All other civil, site block wall, yard piping, water service, mechanical, and electrical work included in the Contract Documents.

11. Testing and Startup and Commissioning as described in Section 017500 – Commissioning.

12. Project Construction Survey – The Contractor shall be responsible to survey the location of all buried piping and fittings. The survey information shall be presented on the Record Drawings and each surveyed point shall have the Northing, Easting, Elevation information and a brief description. The survey shall also include the verification of manhole invert elevations. The survey shall be performed, and data certified by a licensed surveyor in the State of California.

List above is intended to provide an overview of the major project components and does not include all work described in Contract Documents.

B. Type of Contract.

1. Project will be constructed under a single prime contract.

1.4 CONSTRUCTION DOCUMENTS

A. The Contractor may obtain copies of the construction documents as directed in the Instruction to Bidders in Volume 1, "Notice and Invitation to Bidders." Electronic copies of the existing lift station drawings will be available to the successful Contractor through the same means. Note that only limited "record drawings" or "as-constructed drawings" for previous on-site construction projects are available and may not accurately reflect the as-constructed condition.

1.5 PHASED CONSTRUCTION

A. The Work shall be conducted in accordance with an approved Contractor's Schedule.

    1. It is expected that the project will consist of a single phase(s). Work on the project initial phase shall commence simultaneously with the Notice to Proceed and be substantially complete and ready for full use Three Hundred and Sixty-Five (365) calendar days after the issue of Notice to Proceed.

B. Phases:

    1. The project consists of a single phase of work, however, the single phase must be sequenced to maintain the lift station continuously All work is to be completed in 365 calendar days from the issue of Notice to Proceed.

C. The Contractor's Schedule shall include completion dates. It shall also be coordinated with the sequencing plan. It is anticipated and expected that work will begin with the issue of the Notice to Proceed.

1.6 SITE OPERATION DURING CONSTRUCTION:

A. Continuous operation of the Owner's existing facilities is of critical importance. The purpose of the following is to provide a general overview of the operations and critical facilities that must remain in operation during the construction:

    1. Existing Facility Description: The existing facility consists of a wet well/dry pit lift station, several gravity conveyance manholes, odor control system and associated instrumentation and electrical gear. Currently, there are three pumps installed in the dry pit and the odor control is not functional.
    2. During construction, the existing facility must remain in operation. Therefore, a sequential removal and construction approach is required.

1.7 CONSTRUCTION AND SCHEDULE CONSTRAINTS

    1. Construction of the Work may require short disruptions of individual or multiple processes at the existing lift station to make critical connections or replace existing pumps, pipelines, and infrastructure. Contractor shall schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified. Contractor shall provide temporary facilities, bypass systems, or other approved means to ensure continuous operation of lift station to meet system operational and emergency demands.

2. Contractor shall notify Engineer and Owner in writing at least 14 working days in advance of any operation that will disrupt Owner's facilities or operations or any required shutdown. Prior to removing any portion of the existing facilities, submit and obtain Engineer and Owner approval for all submittals required to construct the proposed improvements.
3. Clearly demonstrate in the CPM Schedule and other submittals, to the satisfaction of the Owner and the Engineer, the Contractor's ability to complete the Work requiring an interruption of service (shutdown work) within the allowable duration.
4. If the Contractor does not clearly demonstrate the ability to complete the shutdown work in the CPM Schedule proposed during a shutdown period, the Owner reserves the right to limit the scope of the shutdown work which the Contractor may undertake.
5. Opportunities for shutdown of existing lift station operation will be limited to periods of low flows and of very limited duration. The periods of daily low flows are typical associated with hours between 10:00 PM and 6:00 AM.
6. For all shutdowns, the Contractor shall provide emergency bypass equipment for the process or equipment capable of meeting the current peak flowrate. The Contractor shall prepare a submittal of the equipment for approval by the Owner prior to scheduling all shutdowns.

1.8 SEQUENCE OF CONSTRUCTION

A. The following paragraphs are provided as guidance to the Contractor with the intent of providing general information regarding the required sequencing of construction of individual processes and infrastructure. It is not the intent of the following paragraphs to identify all the work required to be in place for a given process to be Substantially Complete. Thus, items such as utility water connections, access roads, plant drain system, and process piping may not be specifically listed and discussed.

B. The listing of items below also does not indicate or imply that all constraints or special conditions have been identified. The list is not a substitute for the duty of the Contractor to coordinate and plan for completion, all Work by the Substantial/Contract Completion Dates specified in the Contract Documents. The Contractor is responsible for all coordination and scheduling with the plant staff and personnel. The Contractor shall verify that all processes are available before the start-up of the systems. Also, some of the process infrastructure may be constructed (but not Substantially Complete) simultaneously, or ahead of the identified process predecessors. It is noted that the guidelines may change upon a more detailed review of the scheduling. The Engineer is not responsible for scheduling the Contractor’s work.

1. <u>Task 1 – Construction of Emergency Storage Basin</u>

Construction Predecessor: Mobilization

For this task to be completed, the following activities must be completed:

a. Construction of Concrete Emergency Storage Basin
b. Installation of basin cover (ADD ALTERNATE)
c. Installation of NPW system
d. Connection to existing MH#1 (may require bypass pumping)

Construction Notes and Work Constraints: Coordinate all work with City’s staff. This work will also require coordination with BCVWD.

2. Task 2 – Partial Removal of Existing Pumps and Piping

Construction Predecessor: Delivery of new pumps and associated electrical equipment.

For this task to be completed, the following activities must be completed:

a. Partial removal of one (1) existing pump and existing pump discharge and 16-inch manifold piping.
b. Installation and testing of portion of new suction and discharge piping
c. Installation and testing of two (2) new pumps (P-11261 and P-11241) and associated electrical work and instrumentation.

Construction Notes and Work Constraints: Existing lift station shall remain operational at all times. Consequently, a sequential installation of new pumps and associated discharge piping is required. During the duration of this task, culminating with successful completion of Reliability Acceptance Testing (RAT) of pumps P-11261 and P-11241, two existing pumps and existing 12 -inch discharge manifold shall remain in operation. Note that the pump testing and substantial completion of this task is subject to completion of work on the 16-inch diameter force main in Potrero Blvd and Western Knolls Avenue being implemented under a separate contract. The Contractor shall assume the 16-in diameter force main will be available for use 210 calendar days after the Notice to Proceed for this contract.

3. Task 3 – Partial Removal of the Remaining Existing Pumps and Piping

Construction Predecessor:

a. Delivery of new pumps and associated electrical equipment.
b. Task 2 Substantial Completion

For this task to be completed, the following activities must be completed:

a. Removal of two (2) pumps and associated existing pump discharge and 12-inch manifold piping.
b. Installation and testing of portion of new suction and discharge piping
c. Installation and testing of two (2) new pumps (P-11221 and P-11201) and associated electrical work and instrumentation.

Construction Notes and Work Constraints: Task 2 must be completed and operational. Existing lift station via the two new pumps installed as part of Task 2 shall remain operational at all times.

4. Task 4 – Manhole grinder installation and existing odor control system modifications:

Construction Predecessor:

a. Delivery of new grinder manhole

For this task to be completed, the following activities must be completed:

a. Existing odor control system modification and completion of system RAT.
    1) **The contractor shall engage the odor control system manufacturer to provide the required services to modify the system. Please refer to Appendix B for vendor information regarding the specific required**

activities. Note that it is the contractor's responsibility to verify the cost of the recommended services at the time of the bid.

b. Installation and testing of new grinder manhole and associated electrical gear (may require bypass pumping)

Construction Notes and Work Constraints: Existing lift station shall remain operational at all times. In general, this task may be completed in parallel with any of tasks listed above. The Contractor shall provide a bypass sewage pumping system for this work or propose an alternative approach. The selected approach must be submitted to the Owner for approval, along with all details necessary for complete implementation.

5. Task 5 – CMU Wall Modifications

Construction Predecessor:

a. Emergency Storage Basin Construction

For this task to be completed, the following activities must be completed:

a. Construction of new CMU Wall.
    1) **Please refer to Appendix A included herein for Proto-II wall system design and installation requirements. Proto-II CMU wall shall be installed by a certified installer. Installers certification shall be included with a complete wall system submittal.**

Construction Notes and Work Constraints: Construction of the CMU wall may start at any point following the construction of the Emergency Storage Basin.

C. The Contractor shall prepare and submit a phasing/sequencing plan. The contractor may use the individual process sequencing listed above to propose construction phasing. The proposed phasing plan will be evaluated by the Engineer and the Owner prior to approval. When developing the phasing plan, the contractor shall evaluate other construction factors such as the requirement to keep the lift station operational at all times, bypass equipment if required, equipment lead times, and provide adequate access for City's operations and maintenance.

D. The contractor shall coordinate ahead of time utility tie-ins and potential operational interruptions with the City and BCVWD staff and will be responsible for planning and coordinating all aspects of the work. The Contractor is required to submit a detailed work plan for each shutdown or tie-in event.

E. It shall be the responsibility of the Contractor to ensure that the lift station maintains operability throughout the construction. All bypass pumping shall be provided with complete redundancy. The Contractor shall also be held liable for violations of applicable AQMD permits due to construction activities. The Contractor shall be held liable for damages resulting from sewage spills caused by improperly performed shutdowns and bypasses.

F. For each proposed bypass operation, the Contractor shall submit a bypass plan in accordance with Section 020960 of the Specifications. Prior to any bypassing, the plan must be approved by the Owner and Engineer. The Contractor shall be responsible for clean-up and repair of any damage caused during bypassing.

1.9 ACCESS TO SITE

A. General: Contractor shall have full use of Project site, defined as the limits of construction, for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to maintain the operation of the lift station, perform work or to retain other contractors for work on the site or facilities. Owner will inform the contractor of areas that are essential for facility operation which shall not be disturbed, blocked, or impacted by the construction efforts.

B. Use of Site: Limit use of Project site to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

   1. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

      a. Schedule deliveries to minimize use of driveways and entrances by construction operations.

   2. Contractor shall coordinate with the City and provide access during construction to the lift station for operating, cleaning, and maintenance of all facilities. Access route and layout shall be coordinate with the City and any changes shall require approval from the City.

1.10 OCCUPANTS

A. Full Owner Occupancy: Owner will occupy site during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.

   1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
   2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

B. Work Restrictions, General: Comply with restrictions on construction operations.

   1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

C. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 5:00 p.m., Monday through Friday, except City Recognized Holidays, unless otherwise indicated and/or agreed with the Owner all in accordance with General Conditions.

D. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.

E. Noise, Vibration, and Odors: Coordinate with Owner all operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy.

   1. Notify Owner not less than two days in advance of proposed disruptive operations.

F. Smoking requirements are to comply with California State law.

1.11 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

   1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
   2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. General and Special Conditions: Requirements of General and Special conditions provided in Volume I of Contract Documents apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

   1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
   2. Abbreviations: Materials and products are identified by abbreviations and scheduled on Drawings.
   3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

END OF SECTION 011000

SECTION 011002-SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 Work Included

A. General control sequence for:
   1. In-line Grinder Operation
   2. Lift Station Operation
   3. Automated Valve Operation
   4. Sump Pump for Dry Well

B. Instruments and equipment shall be constructed by Contractor.
   1. SCADA programming will be done by City.

C. Refer to Section 011000 for a summary of construction activities and construction sequencing.

D. The existing lift station must remain in operation at all times.

1.2 Related Work

A. Section 011000: Summary of Work
B. Section 013300: Contractor Submittals
C. Section 016600: Equipment Testing and Startup
D. Section 017500: Commissioning
E. Section 260000: General Electrical Requirements
F. Section 262923: Variable Frequency Motor Controllers
G. Section 407113: Magnetic Flow Meters
H. Section 407223: Radar Level Meters
I. Section 407276: Level Switches
J. Section 407313: Pressure and Differential Pressure Gauges
K. Section 407336: Pressure and Differential Pressure Switches
L. Section 400557: Actuators for Process Valves and Gates
M. Section 432010: Pumps, General
N. Section 432513: Dry Pit Screw Centrifugal Pumps
O. Section 462413: Manhole Grinder System

1.3 System Description

A. The overall system includes following process components:
   1. Gravity collection system piping
   2. In-line, manhole grinder system (ME-10201)
   3. Emergency storage basin
   4. Lift station wet well
   5. Lift station dry pit
   6. Four (4), dry pit screw centrifugal pumps
   7. Dry pit sump pumps
   8. Screw pump discharge piping with associated instrumentation and isolation and flow

control valves.

9. Two (2) parallel force main (FM) lines (12 and 16-inch diameter)

1.4 Normal System Operation

A. No controls or specific process operational activities are associated with the collection system located on site.

B. The in-line manhole grinder system shall operate continuously in “REMOTE” mode. Remote run command shall be provided by the PLC and shall keep the grinder running until “OFF” in manual switch is selected or Fault is detected.

C. Emergency Storage Basin – no controls or specific process operational activities are associated with the emergency storage basin operations.

   1. The level indicating transmitter LT-10101 returns a liquid level measurement in the basin. This measurement will return to the PLC and become displayed on SCADA for monitoring by operation and maintenance staff. In addition, a high liquid level alarm will be generated once the liquid elevation is at 2424.75.
   2. Backup level alarms and control shall be provided by level switches LSL-10102 and LSH-10102. Mechanical limit switches provide redundancy and protection to other equipment in the case of LT failure.

D. Screw Centrifugal Pumps

   1. The lift station total flow capacity is 5,200 gpm, with each pump having a capacity of 1,750 gpm at 228 feet of head.
   2. The lift station configuration allows operation of all four pumps, but only three (3) pumps are required to provide the design flow resulting in a 3 Duty + 1 Standby pump configuration.
   3. For normal operations, two pumps P-11201 and P-11221 will be dedicated to servicing the 12-inch force main and two pumps P-11241 and P-11261 will be dedicated to servicing the 16-inch force main. To meet the maximum design flow (5,200 gpm) requirement, three (3) pumps will be operated simultaneously with two pumps pumping into the 16-inch FM and one into the 12-inch FM.
   4. To ensure similar run times, at any time, one of the 4 pumps will be automatically selected as the lead pump. Operations and maintenance staff can select various methods of choosing lead and lag operation, be it, run hours, sequential or time based.
   5. In this mode of operation, the actuated valves are in following positions:
      a. FV-11281 – OPEN
      b. FV-11291 – OPEN
      c. FV-11272- CLOSED

E. Pump primary level-controlled operating sequence in AUTO mode shall be:

   1. The primary pump shall be turned on automatically based upon a wet well level set point selected by the operating staff (See Section G) provided by level transmitter LIT-11202.
   2. Pump speeds shall be controlled from PLC using a linear level controller – as the wet well level rises pump speeds increase and/or bring on additional pumps. Refer to sections F and G below for typical pump cycle and level control set points respectively.
   3. Pump speed setpoints, and control will be provided to the operator through SCADA.
   4. Safety alarms described below will be monitored by the PLC and provide protection to the equipment and control to the operation staff.

- VFD Fault
- Motor High Temperature
- Bearing High Temperature
- Internal Moisture
- Pump Dry Chamber
- High Discharge Pressure
- Low Wet Well Level
- Discharge Flow
- Valve Positions (FV-11281, FV-11272, FV-11291)
- HOA Position

5. Typical pump cycle shall be as described below:
   a. Primary (Lead) Pump P-11201 or P11221 ON (flow in 12” FM)
   b. Lag #1 Pump P-11241 or P-11261 ON (flow in 16” FM)
   c. Lag #2 Pump P-11241 or P-11261 ON (flow in 16” FM)
6. In the event the PLC fails, hardwired controls from the float system will enable pump operation. Timer control and float signals will start pumps at a preset speed programmed into the VFD upon high level conditions and stop upon low level conditions in the wet well.

F. Level Control:

1. Elevation Set Points

LEVEL (Elevation)	Control	Remarks
2410.50	Wet Well Low Low Level Alarm	LSL-11203
2410.58	Wet Well Low-Level Alarm	LIT-11202
2410.83	Lead/Primary Pump OFF	-
2411.58	Lead/Primary Pump ON	Low Speed
2411.83	Lead Pump Target Level Control	-
2412.07	Lag Pump #1 OFF	-
2412.58	Lag Pump #1 Pump ON	Low Speed
2413.07	Lead/Lag #1 Pump Target Level Control	-
2413.58	Lag Pump #2 OFF	-
2414.07	Lag Pump #2 ON	Low Speed
2414.58	Lead/Lag #1, #2 Pump Target Level Control	-
2415.83	High Wet Well Level Alarm	LIT-11202
2416.33	High-High Alarm	LSH-11203
2414.58	Standby Pump OFF	Emergency Operation
2415.33	Standby Pump ON	Emergency Operation – Low Speed
2415.58	All pumps in operation Target Level Control	Emergency Operation

2. Elevation control instrumentation:

a. Primary: Level control indicator transmitter LE/LIT-11202
b. Alarm backup shall be provided by level switches LSL-11203 and LSH-11203.

G. Pump primary level-controlled operating sequence in AUTO mode shall be:
1. VFD speed shall be controlled from PLC based on wet well level.
2. The VFD will ramp up the speed of the selected lead pump within 0-300 seconds (initial setting 120 seconds) to maintain a preset level in the wet well.
3. The VFD will shut down under any of the following circumstances:
   a. An alarm condition occurs.
   b. The system is manually shut down.
4. Hydraulic-generated alarm conditions may include:
   a. Low wet well level.
   b. No flow (check valve not opening).
   c. High pressure
5. Motor-generated alarm conditions may include:
   a. Loss of control signal
   b. Motor overcurrent
   c. Motor failure
   d. Motor high temperature
   e. Bearing high temperature
   f. Internal Conductivity
   g. Dry Chamber
6. VFD-generated alarm conditions may include:
   a. Power loss
   b. Communication Fail
   c. Emergency Stop
   d. VFD overcurrent
   e. VFD overvoltage
   f. VFD undervoltage
   g. VFD overtemperature
   h. VFD underspeed
   i. VFD phase-to-phase or phase-to-ground fault
   j. VFD failure or fault

B. Pump primary level-controlled operating sequence in HAND mode shall be similar to AUTO mode with all alarm condition safeties in operation, except the pump speed in HAND mode will not be paced by the wet well level but will revert to a manual controlled speed from the PLC or speed potentiometer on front door of VFD.

H. Dry -Pit Sump Pump Operation
1. Lead pump ON based on energization of LSH-1300A
2. Lag pump ON based on energization of LSH-1300B
3. Lead and Lag pumps OFF based on energization of LSL-1300
4. High water alarm based on energization of LSHH-1300

1.5 Alternative Operations

A. Current design allows for alternative modes of operation. These are typically associated with Emergency operations when one of the force main lines is out of service or in the case of pump replacement and/or maintenance:

1. 12-inch Force Main Out of Service:
   a. Pump AUTO level control outlined in PART G is applicable.
   b. Actuated valve FV-11281 is CLOSED
   c. Actuated valve FV-11291 is OPEN
   d. Actuated valve FV-11272 is OPEN
   e. A maximum of three (3) pumps may be in operation (interlock with FV-11281 position).
   f. Valve OPEN/CLOSE sequence shall be such that FV-11272 is in OPEN position before FV-11281 starts to close.
2. 16-inch Force Main out of Service:
   a. Pump AUTO level control outlined in PART G is applicable.
   b. Actuated valve FV-11291 is CLOSED
   c. Actuated valve FV-11281 is OPEN
   d. Actuated valve FV-11272 is OPEN
   e. A maximum of two (2) pumps may be in operation (interlock with FV-11291 position).
   f. Valve OPEN/CLOSE sequence shall be such that FV-11272 is in OPEN position before FV-11291 starts to close.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 Field Quality Control

A. Field testing of complete control systems during facility commissioning shall conform to Sections 017500 and 406113.

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. Coordination drawings.
2. Requests for Information (RFIs).
3. Requests for Change (RFCs)
4. Project Web site.
5. Project meetings.

1.2 DEFINITIONS

A. RFI: Request from Owner, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

B. RFC: Request from Contractor proposing a change to the contract requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

1.4 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

    1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

    1. Preparation of Contractor's construction schedule.
    2. Preparation of the schedule of values.
    3. Installation and removal of temporary facilities and controls.
    4. Delivery and processing of submittals.
    5. Progress meetings.
    6. Preinstallation conferences.
    7. Project closeout activities.
    8. Startup and adjustment of systems.

1.5 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

    1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

        a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
        b. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

    1. Site Plan and Utilities: Show new and existing equipment pads, wet well, dry pit, storage basin, underground utilities and perimeter walls.

    2. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. (if applicable)
    3. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. (if applicable)

4. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
5. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
6. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
7. Review: Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility.

1.6 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified. A sample RFI form is included at the end of this Specification.

1. Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
3. Owner or Engineer will not review the Contractor’s RFIs that are in fact Requests for Changes (RFCs), as determined by the Owner. In such cases, Contractor will be required to resubmit on the appropriate RFC form.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Engineer.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Engineer.

D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven (7) working days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. PST will be considered as received the following working day.

1. The following RFIs will be returned without action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for coordination information already indicated in the Contract Documents.
d. Requests for adjustments in the Contract Time or the Contract Sum.
e. Requests for interpretation of Engineer's actions on submittals.
f. Incomplete RFIs or inaccurately prepared RFIs.

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.
3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit a Change Proposal.

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer and Construction Manager in writing within 10 (10) days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Software log with not less than the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Engineer.
4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date Engineer's response was received.

F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven (7) days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.7 REQUEST FOR CHANGE (RFCs)

A. Contractor shall submit a Request for Change when Contractor proposes a change in the Contract requirements. All change requests shall be submitted on the RFC form attached to this Specification. As shown therein, Contractor is required to fully describe the benefit(s) to the Owner, benefit(s) to the Contractor, the cost and/or schedule impact(s) associated with the requested change, along with whether or not Contractor proposes or requires a Contract Change

Order for implementing the change. Except for as described in Section 1.6 herein, any Contractor RFC that is submitted on the RFI form will be returned without review.

B. As noted on the RFC form, it is understood that certain RFCs can be responded to promptly, with minimal expenditures required by Owner. It is also understood that other RFCs require significant expenditures by Owner in order to properly evaluate and respond to Contractor’s RFC. For those RFCs that fall in the latter category, Owner will provide an estimate (time and money) to Contractor as an initial response to RFC. Contractor may then elect to have Owner proceed with evaluating Contractor’s RFC (with estimated value deducted from Contractor’s Contract with the Owner), or elect to withdraw Contractor’s RFC.

1.8 PROJECT MEETINGS

A. General: Construction Manager will schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Construction Manager, and Engineer, within three (3) days of the meeting.

B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than fifteen (15) days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner, Construction Manager, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

   a. Tentative construction schedule.
   b. Phasing.
   c. Critical work sequencing and long-lead items.
   d. Designation of key personnel and their duties.
   e. Procedures for processing field decisions and Change Orders.
   f. Procedures for RFIs.
   g. Procedures for testing and inspecting.
   h. Procedures for processing Applications for Payment.
   i. Distribution of the Contract Documents.
   j. Submittal procedures.
   k. Preparation of record documents.
   l. Use of the premises and existing building.
   m. Work restrictions.
   n. Working hours.

o. Owner's occupancy requirements.
p. Responsibility for temporary facilities and controls.
q. Procedures for disruptions and shutdowns.
r. Construction waste management and recycling.
s. Parking availability.
t. Office, work, and storage areas.
u. Equipment deliveries and priorities.
v. First aid.
w. Security.
x. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer, Construction Manager of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. Contract Documents.
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility problems.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Construction Manager will conduct progress meetings at weekly intervals.

1. Attendees: In addition to representatives of Owner, Construction Manager, and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Contractor shall prepare three-week look ahead schedules for review at each progress meeting. The three-week look ahead schedules are not an acceptable substitute for CPM schedule updates that must be submitted with Contractor’s monthly partial payment requests.

c. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Status of documentation.
5) Deliveries.
6) Off-site fabrication.
7) Access.
8) Site utilization.
9) Temporary facilities and controls.
10) Progress cleaning.
11) Quality and work standards.
12) Status of correction of deficient items.
13) Field observations.
14) Status of RFIs.
15) Status of proposal requests.
16) Pending changes.

17) Status of Change Orders.
18) Pending claims and disputes.
19) Documentation of information for payment requests.

3. Minutes: Entity responsible for conducting the meeting will electronically record, transpose and distribute the meeting minutes to each party present and to parties requiring information.

   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

4. It is noted that inspection will not be provided during scheduled progress meetings. Contractor is not permitted to perform work that requires inspection (as determined by Owner) during the progress meetings. Contractor shall adjust his schedule to accommodate said weekly progress meetings and no additional compensation will be provided for same. Contractor’s bid shall consider Owner’s requirements for weekly progress meetings. Owner, at its sole discretion, may decrease the frequency of progress meetings if deemed appropriate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

SAMPLE

CONTRACTOR'S REQUEST FOR INFORMATION (RFI) #__________

To (Engineer):	
From (Contractor):	
Subject:	
Reference: Construction Drawing:	Specification (Section and Page):
REQUEST	
Information is requested as follows:	
Information Requested By (Name):	**Date**:
Response Requested By (Date):	
Received by CM (Date):	
RESPONSE	
Response to Information Request:	
Response By (Name):	**Date**:

Final Distribution:

Page ___ of ___

SAMPLE
CONTRACTOR'S REQUEST FOR CHANGE (RFC) #__________

<table>
<tr><td colspan="2">To (Engineer):

</td></tr>
<tr><td colspan="2">From (Contractor):

</td></tr>
<tr><td colspan="2">Subject:</td></tr>
<tr><td>Reference: Construction Drawing:</td><td>Specification (Section and Page):</td></tr>
<tr><td colspan="2" align="center">REQUEST</td></tr>
<tr><td colspan="2">The following change is requested:

</td></tr>
<tr><td>Change Requested By (Name):</td><td>Date:</td></tr>
<tr><td colspan="2">Response Requested By (Date):</td></tr>
<tr><td colspan="2">Received by CM (Date):</td></tr>
<tr><td colspan="2">Benefit to Owner:

</td></tr>
<tr><td colspan="2">Benefit to Contractor:

</td></tr>
<tr><td colspan="2">Cost and/or Schedule Impact:

</td></tr>
<tr><td colspan="2">Change Order Required or Proposed? ____ YES ____ NO</td></tr>
<tr><td colspan="2" align="center">RESPONSE</td></tr>
</table>

Response to Change Request: [1]	
RESPONSE (Continued)	
Response By (Name):	**Date**:

(1) It is understood that certain RFCs can be responded to promptly, with minimal expenditures required by Owner. It is also understood that other RFCs require significant expenditures by Owner in order to properly evaluate and respond to Contractor's RFC. For those RFCs that fall in the latter category, Owner will provide an estimate (time and money) to Contractor as an initial response to RFC. Contractor may then elect to have Owner proceed with evaluating Contractor's RFC (with estimated value deducted from Contractor's Contract with Owner), or elect to withdraw Contractor's RFC.

Final Distribution:

END OF SECTION 013100

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 013130 - SAFETY

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor's safety program shall conform to the requirements specified in the General Conditions.

B. This specification provides general guidance for site safety and a site safety program.

1.2 DEFINITIONS

A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring or construction activities could be considered a potential hazard to people.

B. A "Designated Safety Officer" or "Safety Representative" for the purposes of this Contract, means anyone who is capable of identifying the existing and predictable hazards in the areas surrounding a construction project or those working conditions at a construction project that are unsanitary or dangerous to employees. A "Designated Safety Officer" has the authority to make prompt corrective measures to eliminate those hazards.

C. For the purposes of this Section, a "classified area" represents any area within the classified boundary or envelope of an active wastewater treatment process basin, channel, or other facility. A table summarizing the classified areas present within the boundaries and scope of this project is provided in paragraph 1.4 of this Section.

1.3 SUBMITTALS

A. Demonstrate compliance action with the stipulations of California Occupational Safety and Health Administration (CAL OSHA), Mine Safety and Health Administration (MSHA), and other applicable local, state, and federal safety requirements by submitting to Engineer a copy of all safety plans, programs, and permits. Such plans and programs shall include, but are not limited to:

1. Hazard Analysis Prior to Major Activities (job safety analysis, JSA).
2. Emergency Plan.
3. Rigging and Hoisting Plans.
4. Excavation and Trenching Plans.
5. Respiratory Protection Program.
6. Fire Protection Plan.
7. Confined Space Entry Program.
8. Explosives Handling and Storage.
9. Confined Space Entry Program.
10. Electrical Safety (drop cords, temporary power, GFCI's, etc.)
11. Lock Out/Tag Out.
12. Fall Protection.
13. Heavy Equipment Operations.
14. Burning and Welding Operations.
15. Training Plan.
16. Tunneling/Underground/Jacking/Boring Operations.

17. Project Site Rules and Regulations (hazard protection plan).
18. Material Handling (storage-disposal).
19. Fuel Storage and Refueling.
20. Hazard Communication/Right to Know.
21. Subcontractor Requirements.
22. Ventilation.
23. Personal Protective Equipment (hearing, eye, face).
24. Power Transmission/Distribution (temporary and/or permanent).
25. Traffic Control.
26. Environmental Controls.
27. Safety Meetings.
28. Spill Control Plan.
29. First Aid Facilities.

B. Engineer's receipt of safety plans or programs will not relieve Contractor in any way from the full and complete responsibility for safety and training of its personnel, and the onsite personnel of Owner, Engineer, and other visitors to areas of active construction areas. On a daily basis, inform Engineer of changes to the boundaries of the active construction areas.

C. Be responsible for safety training all personnel who will have access to the active construction areas to meet state, federal, local and Contractor requirements. Maintain reasonable, regularly scheduled training sessions in mutually accessible facilities through entire Contract. Training costs for all personnel and visitors, except those costs associated with training personnel of Contractor, subcontractors, suppliers, and visitors will be considered incidental to other lump-sum portions of the Work and no additional compensation for such training will be provided.

D. Safety Program Requirements:
   1. Safety Representative Requirements:
      a. Assign a full-time Safety Representative.
      b. The Safety Representative's duties and responsibilities will be hazard recognition, accidents prevention, new employee orientation (including subcontractors), and the maintaining and supervising of safety precautions and program. This person shall have no other duties. The Safety Representative or a qualified and approved deputy shall be onsite at all times while Work is ongoing.
      c. Qualifications of the Safety Representative and assigned deputies shall be submitted to Engineer for review. Acceptance of their qualifications by Engineer is required prior to the start of any activity on the Project. The Safety Representative will, as a minimum, meet the requirements of regulations per the CAL OSHA Enforcement Branch Program.
   2. Hazardous Substances:
      a. Provide Engineer with a list of all hazardous substances anticipated to be brought on-site.
      b. Maintain on site Material Safety Data Sheets (MSDS) prior to arrival of any hazardous substances on the Project.
      c. Use storage area(s) as outlined in the spill control plan.
   3. Job Safety Analysis (JSA):
      a. Outline the sequence of the Work, equipment to be used, identify hazards that may exist or may be created and what procedures and/or safety equipment will be used to eliminate or reduce these hazards. A Scope of Work JSA shall be prepared and provided to the Engineer prior to the start of unusual, hazardous, or have risk

potential activities on the Project. The name of the competent person assigned to this activity will be included on the JSA.

b. Complete a JSA for any activity, which may be of an unusual nature or involves unique hazards.

4. Reports

a. Provide to Engineer copies of Contractor's and subcontractor's:

1) First aid, recordable, lost time and near miss, monthly logs.

2) OSHA 200 injury log (annually).

3) Safety meeting reports and topics (weekly).

4) List of competent persons as required by OSHA and the Project Health and Safety Manual for each required task and their qualification as such.

5) Injury and accident reports will be submitted to Engineer within 24 hours of any incident. **Immediate** notification to Engineer of an accident is **required**. Full cooperation with Engineer in accident investigation is required.

b. Conduct weekly safety inspections. Corrective actions shall be taken within 24 hours to address all deficiencies identified during inspections. Deficiency reports shall be prepared and submitted to Engineer within 48 hours indicating corrective actions taken. Failure to comply with required corrective measures identified in the safety inspection will result in the delayed signing of the monthly application for progress payment by Engineer.

c. Provide Engineer with a report of any periodic audit of Contractor's safety performance and/or records.

1.4 CLASSIFIED AREAS

A. The Site is an active wastewater lift station that must remain operational and online at all times. Consequently, construction activities for this project will involve working near and and with equipment that must remain online and operational. In addition to the usual hazards of open, deep structures, manholes and equipment/machinery that is actively operating, many of these structures are considered classified zones (per NFPA 820) with potential hazards for fire and explosions due to the presence of explosive gases associated with wastewater.

B. Contractor shall take all additional precautions necessary when working within the classified zones and envelopes in these areas to prevent sparks, open flames, ignitions, and reduce the risk of fire or explosion. Precautions include but are not limited to: reviewing classified areas with all workers and subcontractors as part of the regular safety meetings and site orientation; providing proper PPE for workers entering classified areas; avoid using electrical tools, plugs, extension cords, welding equipment, open flames/heaters, and other potential sources for sparks or ignition within the classified envelopes; and following all guidelines and recommendations provided in NFPA and CALOSHA for working in classified areas,

C. Refer to Electrical Site Layout Drawings for NFPA 820 classified areas.

END OF SECTION 013130

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's construction schedule.
2. Construction schedule updating reports.
3. Daily construction reports.
4. Site condition reports.

1.2 RELATED SECTIONS:

A. General Conditions

B. Section 013300 “Contractor Submittals”

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF electronic file.
3. Two (2) paper copies.

B. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working electronic copy of schedule labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.

E. Construction Schedule Updating Reports: Submit with Applications for Payment.

F. Daily Construction Reports: Submit at weekly intervals to the Construction Manager.

G. Site Condition Reports: Submit at time of discovery of differing conditions.

1.5 COORDINATION

A. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than twenty (20) days, unless specifically allowed by Engineer.
2. Procurement Activities: Include procurement process activities for the long lead items, major items, and Owner Selected equipment requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times in schedule as indicated in Section 013300 "Contractor Submittals." Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
4. Startup and Testing Time: Include no **fewer than fifteen (15) days** for startup and testing.
5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Engineer's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
6. Punch List and Final Completion: Include **not more than thirty (30) days** for completion of punch list items and final completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work under More Than One Contract: Include a separate activity for each contract.
3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
4. Work Restrictions: Show the effect of the following items on the schedule:

   a. Coordination with existing construction.
   b. Limitations of continued occupancies.
   c. Uninterruptible services.
   d. Partial occupancy before Substantial Completion.
   e. Use of premises restrictions.
   f. Provisions for future construction.
   g. Seasonal variations.
   h. Environmental control.

5. Work Stages: Indicate important stages of construction for each major portion of the Work.

D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

E. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and Contract Time.

F. Recovery Schedule: When periodic update indicates the Work is fourteen (14) or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule.

G. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare a computerized Work Break Down schedule utilizing Primavera Project Management, most current version.

B. Startup Network Diagram: Submit diagram within fourteen (14) days of date established for the Notice to Proceed. Outline significant construction activities for the first ninety (90) days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's construction schedule using a time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than sixty (60) days after date established for the Notice to Proceed.

   a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Engineer's approval of the schedule.

2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
3. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

    a. Preparation and processing of submittals.
    b. Mobilization and demobilization.
    c. Purchase of materials.
    d. Delivery.
    e. Fabrication.
    f. Utility interruptions.
    g. Installation.
    h. Work by Owner that may affect or be affected by Contractor's activities.
    i. Testing and commissioning.
    j. Punch list and final completion.
    k. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

    a. Sub networks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the schedule of values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.

2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

H. Responsible Person:
1. Designate, in writing and within five (5) calendar days after Notice of Award, person responsible for preparation, maintenance, updating, and revision of all schedules.
2. Qualifications of Responsible person:
    a. Authority to act on behalf of Contractor.
    b. 5 years verifiable experience in preparation of complex construction schedules for projects of similar value, size, and complexity.
    c. Knowledge of critical path method (CPM) scheduling utilizing Primavera Project Planner software.
3. References: Submit written reference of 3 project Owners who have personal experience with this scheduler on previous projects. Identify name, address, telephone number, project name, and cost.
4. Scheduler: Dedicated full time to this project, located on-site. All scheduling software and hardware located on-site. Scheduler will attend all project meetings called for as specified in section 013100.
5. Engineer reserves the right to disapprove scheduler when submitted by Contractor if not qualified. Engineer reserves the right to remove the scheduler from the project if found to be incompetent.

2.3 REPORTS

A. Daily Construction Reports: The Contractor shall prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events.
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Work Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.

19. Substantial Completions authorized.

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

C. Quarterly Reports: The Contractor shall assist the Engineer, as requested, in preparing quarterly reports, which shall include at a minimum, the following:
1. A summary of progress to date including a description of progress since the last report, percent construction complete, percent contractor invoiced, and percent schedule elapsed.
2. A description of compliance with environmental requirements.
3. A listing of change orders including amount, description of work, and change in contract amount and schedule.
4. Any problems encountered, proposed resolution, schedule for resolution, and status of previous problem resolutions.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Engineer, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 013300 – CONTRACTOR SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals. The Contractor shall coordinate the submittal requirements in this section with those given in the General and Special Conditions of Volume 1, "Bid and Contract Documents." Where discrepancies exist, the requirements of Volume 1 shall govern.

B. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
2. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action.

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.

B. Construction Schedule: Within fourteen (14) days after the date of Notice to Proceed, the Contractor shall submit a construction schedule providing the starting and completion dates of the various stages of the Work. The Contractor shall be prepared to discuss its construction schedule at the pre-construction conference.

C. Schedule of Values or lump sum price breakdown: Within fourteen (14) days after the date of Notice to Proceed, the Contractor shall submit a schedule of values or lump sum price breakdown for progress payment purposes.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Engineer's Digital Data Files: Electronic copies of digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.

1. Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.

   a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
   b. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Engineer.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

   a. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow fifteen calendar (15) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.

2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.

3. Resubmittal Review: Allow fifteen (15) days for review of each resubmittal.

4. Submittal Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A)

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:

   a. Project name.
   b. Date.
   c. Name and address of Engineer.
   d. Name of Construction Manager.
   e. Name of Contractor.
   f. Name of firm or entity that prepared submittal.
   g. Names of subcontractor, manufacturer, and supplier.
   h. Category and type of submittal.
   i. Submittal purpose and description.
   j. Specification Section number and title.
   k. Specification paragraph number or drawing designation and generic name for each of multiple items.
   l. Drawing number and detail references, as appropriate.
   m. Location(s) where product is to be installed, as appropriate.
   n. Related physical samples submitted directly.
   o. Indication of full or partial submittal.
   p. Transmittal number.
   q. Submittal and transmittal distribution record.
   r. Other necessary identification.
   s. Remarks.

5. Metadata: Include the following information as keywords in the electronic submittal file metadata:

   a. Project name.
   b. Number and title of appropriate Specification Section.
   c. Manufacturer name.
   d. Product name.

E. Options: Identify options requiring selection by Engineer.

F. Deviations: Identify deviations from the Contract Documents on submittals.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements:

1. Action Submittals: Submit one (1) electronic copy of each submittal unless otherwise indicated.
2. Informational Submittals: Submit one (1) electronic copy unless otherwise indicated.
3. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

    a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
    b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

    a. Wiring diagrams showing factory-installed wiring.
    b. Printed performance curves.
    c. Operational range diagrams.

d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

a. Generic description of Sample.
b. Product name and name of manufacturer.
c. Sample source.
d. Number and title of applicable Specification Section.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

a. Number of Samples: Submit two (2) full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit two (2) sets of Samples. Engineer will retain one (1) Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.

1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Submit product schedule in the following format:

a. Four (4) paper copies of product schedule or list unless otherwise indicated. Engineer will return three (3) copies.

F. Coordination Drawings Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."

G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."

I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."

J. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of engineers and owners, and other information specified.

L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure

Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

R. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.

T. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000 "Quality Requirements."

U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three electronic copies of the certificate(s), signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents. In the case of shop drawings, each sheet shall be so dated, signed and certified.

3.2 ENGINEER'S ACTION

A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:

1. “NO EXCEPTIONS TAKEN” or “EXCEPTIONS AS NOTED” will require no formal revision and resubmission.

2. “REVISE AND RESUBMIT” or “REJECTED” will require the Contractor to revise said submittal and shall resubmit the required number of copies of said revised submittal to the Engineer.

C. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

F. Fabrication of an item shall commence only after the Engineer has reviewed the submittal and returned copies to the Contractor marked either “NO EXCEPTIONS TAKEN” or “EXCEPTIONS AS NOTED”. Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

END OF SECTION 013300

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
2. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.
3. Specific test and inspection requirements are not specified in this Section.

1.2 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer or Construction Manager.

C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five (5) previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.3 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

B. In instances where a conflict arises between standards and/or between the Technical Specifications and the Design Drawings, the more stringent standard or requirement shall govern at the discretion of Owner and Engineer.

C. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.4 INFORMATIONAL SUBMITTALS

A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Engineer.
2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Engineer.

B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

1.5 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

B. Manufacturer's Field Reports: Prepare written information documenting tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
5. Other required items indicated in individual Specification Sections.

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

1.6 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Manufacturer's Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.

b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
d. When testing is complete, remove test specimens, assemblies, and mockups, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, through Construction Manager, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Engineer or Construction Manager.
2. Notify Engineer and Construction Manager seven (7) days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Engineer's and Construction Manager's approval of mockups before starting work, fabrication, or construction.

   a. Allow seven (7) days for initial review and each re-review of each mockup.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed unless otherwise indicated.

K. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.

1.7 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services. It is the Contractor’s responsibility to schedule the testing provided by such agencies.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Owner will engage a qualified testing agency to perform following services:
1. Soil Density Testing
2. Cast -in -Place concrete testing
3. Special Inspections

C. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least twenty-four (24) hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

D. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Engineer, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Engineer, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.

3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.8 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections and in Statement of Special Inspections included in the Contract Documents (Drawings), and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
2. Notifying Engineer, Construction Manager, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer, through Construction Manager, with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and re-inspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's and Construction Manager's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014120 – PERMITS

PART 1 - GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

A. Obtain permits required for the execution of Work in accordance with the Contract Documents. Provide copies of these permits to Owner.

B. The intent of this Section is to furnish the known list of required permits for the Work under the Contract Documents. Contractor is responsible for determining and verifying the extent of all permits required and for obtaining such permits.

C. In the Bid Price, include costs for obtaining all necessary permits, including application fees and other costs, and the costs of complying with the conditions of all permits. Any fees listed in this section are estimates and are for information only. Verify and pay all actual fees.

D. Within 30 Days of the Limited Notice to Proceed, submit a list of all permits and licenses to be obtained, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

1.2 SUMMARY OF PERMITS TO BE OBTAINED BY CONTRACTOR

A. Obtain the following permits. Submit copies of these permits to Engineer and maintain copies on-site. Comply with all conditions of the permits and pay all applicable fees. Types of permits that may be required include:

1. SWPPP
2. Any required construction permits from City, County, or State agencies
3. Permits for road construction
4. Permits for transport of equipment and materials to/from the site.
5. Permits for disposal of any debris or demolition materials (as needed)
6. Permits required for environmental protection including dewatering and discharging of waters.
7. Permits for noise or pollution control as required.
8. All SCE permits, including temporary electrical power .
9. All BCVWD permits, including temporary meters for construction water.
10. All AQMD permits, including payment of fees for the first year of operation of odor control system. The SCAQMD permit to construct shall be transferred into a permit to operate prior to acceptance by the City.
11. Any temporary AQMD permits associated with construction efforts.

1.3 SUMMARY OF PERMITS OBTAINED BY OWNER

A. N/A

END OF SECTION 014120

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 014200 – ABBREVIATIONS AND REFERENCE STANDARDS

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

D. All work specified herein shall conform to or exceed the requirements of the referenced specifications, codes and standards to the extent that the provisions of such documents are not in conflict with the requirements of these Specifications.

E. References herein to "Building Code" shall mean the California Building Code (CBC) of the International Code Council (ICC). The latest edition of the code, as approved and adopted by the agency having jurisdiction, including all addenda, modifications, amendments or other lawful changes thereto, shall apply to the Work.

F. In case of conflict between codes, reference standards, drawings and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to ordering or providing any materials or labor. The Contractor shall bid the most stringent requirements.

G. Applicable Standard Specifications: The Contractor shall construct the Work specified herein in accordance with the requirements of the Contract Documents and the referenced portions of those referenced codes, standards and specifications listed herein.

H. References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

AA	Aluminum Association
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute (Formerly: ACI International)
ACPA	American Concrete Pipe Association
AGA	American Gas Association
AGC	Associated General Contractors
AHRI	Air-Conditioning, Heating, and Refrigeration Institute (The)
AI	Asphalt Institute
AIA	American Institute of Architects (The)
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
APA	APA - The Engineered Wood Association

APA	Architectural Precast Association
API	American Petroleum Institute
APWA	American Public Works Association
ASA	Acoustical Society of America
ASAE	American Society of Agriculture Engineer
ASCE	American Society of Civil Engineers
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASLE	American Society of Lubricating Engineers
ASME	American Society of Mechanical Engineers
ASQC	American Society for Quality Control
ASSE	American Society of Safety Engineers (The)
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials International
ATIS	Alliance for Telecommunications Industry Solutions
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association (The)
BOCA	BOCA (Building Officials and Code Administrators International Inc.)
CDA	Copper Development Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturers Institute
CMA	Concrete Masonry Association
CPA	Composite Panel Association
CRSI	Concrete Reinforcing Steel Institute
DASMA	Door and Access Systems Manufacturers Association
DHI	Door and Hardware Institute
ETL	Electrical Test Laboratories
GA	Gypsum Association
GANA	Glass Association of North America
HI	Hydraulic Institute
HMMA	Hollow Metal Manufacturers Association (See NAAMM)
HPVA	Hardwood Plywood & Veneer Association
ICBO	International Conference of Building Officials (See ICC)
ICC	International Code Council
ICEA	Insulated Cable Engineers Association, Inc.
ICPA	International Cast Polymer Alliance
ICRI	International Concrete Repair Institute, Inc.
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
IES	Illuminating Engineering Society
IPC	Institute of Printed Circuits
IPCEA	Insulated Power Cable Engineers Association
ISA	International Society of Automation
ISO	International Organization for Standardization
LPI	Lightning Protection Institute
MBMA	Metal Building Manufacturers Association
MCA	Metal Construction Association
MHIA	Material Handling Industry of America

MPI	Master Painters Institute
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International (National Association of Corrosion Engineers International)
NAIMA	North American Insulation Manufacturers Association
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	NFPA (National Fire Protection Association)
NFPA	National Forest Products Association
NFRC	National Fenestration Rating Council
NHLA	National Hardwood Lumber Association
NIST	National Institute of Standards and Technology
NLGI	National Lubricating Grease Institute
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	NSF International (National Sanitation Foundation International)
NSPE	National Society of Professional Engineers
NSSGA	National Stone, Sand & Gravel Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PDI	Plumbing & Drainage Institute
SDI	Steel Door Institute
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SPFA	Spray Polyurethane Foam Alliance
SPRI	Single Ply Roofing Industry
SSPC	Society for Protective Coatings
SSPC	Steel Structures Painting Council
SSPWC	Standard Specifications for Public Works Construction
SWPA	Submersible Wastewater Pump Association
UBC	Uniform Building Code (See ICC)
UL	Underwriters Laboratories Inc.
WASTEC	Waste Equipment Technology Association
WCRSI	Western Concrete Reinforcing Steel Institute
WDMA	Window & Door Manufacturers Association
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

1. DIN- Deutsches Institut fur Normung e. V.; www.din.de.
2. IAPMO – International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC – International Code Council; www.iccsafe.org.
4. ICC-ES – ICC Evaluation Service, LLC; www.icc-es.org.

5. AQMD – Southcoast Air Quality Management District; www.aqmd.gov
6. RWQCB – Santa Ana Regional Water Quality Control Board; https://www.waterboards.ca.gov/santaana/
7. BCDWD – Beaumont Cherry Valley Water District; https://bcvwd.gov/

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USTD – U.S. Department of the Treasury; home.treasury.gov
19. USP - U.S. Pharmacopeial Convention; www.usp.org.
20. USPS - United States Postal Service; www.usps.com.

Note: The above list(s) are not intended to be exhaustive.

END OF SECTION 014200

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

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

B. Related Requirements:

1. Section 011000 "Summary of Work" for work restrictions and limitations on utility interruptions.

2. Requirements given in the General Conditions.

1.2 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.

1.3 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel. Coordinate location with the Owner.

B. Erosion- and Sedimentation-Control Plan for projects disturbing more than 1 acre: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire prevention program.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts.

B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide galvanized-steel bases for supporting posts.

C. Wood Enclosure Fence: Plywood, 6 feet high, framed with four 2-by-4-inch rails, with preservative-treated wood posts spaced not more than 8 feet apart.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Contractor’s Field Office: Of sufficient size to accommodate needs of Owner, Engineer, Construction Manager, and construction personnel office activities and to accommodate Project meetings specified in Section 013100. Keep office clean and orderly.

C. Inspector’s Field Office: Not Required.

D. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

E. Final location of Contractor’s temporary facilities shall be coordinated with the Owner to ensure that access critical to plant operations is maintained at all times.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures. The Contractor shall provide fire extinguishers and other fire protection equipment to adequately protect new and existing facilities and temporary facilities against damage by fire. Hose connections and hose, water casks, chemical equipment or other sufficient means shall be provided for fighting fires in the new, existing and temporary structures and other portions of the Work and responsible persons shall be designated and instructed in the operation of such fire apparatus so as to prevent or minimize the hazard of fire. The Contractor's fire protection program shall conform to the requirements of the OSHA Standards for Construction. The Contractor shall employ every reasonable means to prevent the hazard of fire.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures".

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary of Work."

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

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

1. The Contractor shall provide an adequate supply of water of a quality suitable for all domestic and construction purposes.

2. Non-Potable water is not available on site. If procured from an alternative location, it may be used for grading and hydraulic structures and pipeline testing as approved by the Engineer.

3. The Contractor shall properly identify all construction water trucks and vessels and inform all workmen and the general public when reclaimed waste water is used as construction water.

4. All drinking water on the site during construction shall be furnished by the Contractor and shall be bottled water or water furnished in approved metal dispensers. Notices shall be posted conspicuously throughout the site warning the Contractor's personnel that piped water may be contaminated.

5. The Contractor shall not make connection to, or draw water from, any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the water system. For each such connection made the Contractor shall first attach to the fire hydrant or pipeline a valve, backflow preventer and a meter, if required by the said authority, of a size and type acceptable to said authority and agency.

6. Before final acceptance of the Work all temporary water connections and piping installed by the Contractor shall be entirely removed, and all affected improvements shall be restored to their original condition, or better, to the satisfaction of the Engineer and to the agency owning the affected utility.

C. Waste Collection: Provide trash cans and instruct personnel to maintain a clean site.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Toilets: Portable chemical toilets shall be provided wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction. The Owner's toilet facilities shall <u>not</u> be used by the Contractor's work force.

2. The Contractor shall establish adequate and regular collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of in a manner satisfactory to the Engineer and in accordance with all laws and regulations pertaining thereto.

E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

F. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

G. Electric Power Service: Electric Power Service from Existing System: Electric power from Owner's existing system will be made available for all Field office power requirements and construction activities limited by the site's electrical system capacity as a whole or at a specific location. All use of power from Owner's existing system shall be coordinated with the Owner and shall be associated with the activities related to construction.

The Contractor shall be responsible to provide necessary electrical power. The contractor will be responsible for all temporary power and generators required during the construction and planned power shut-downs. The Contractor shall provide all necessary temporary power connection, disconnects and distribution lines required for its operations under the Contract and shall provide and maintain all temporary power systems required to perform the Work in a safe and satisfactory manner. All temporary connections for electricity shall be subject to approval of the Engineer and shall be completely removed at the Contractor's expense prior to final acceptance of the Work. All wiring for temporary electric light and power shall be properly installed and maintained and shall be securely fastened in place. All electrical facilities shall conform to the requirements of the OSHA Safety and Health Standards for Construction.

H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

I. Telephone Service: <u>The Owner's telephone system shall not be used by the Contractor's work force.</u>

1. Post a list of important telephone numbers in the project field office.

    a. Police and fire departments.
    b. Ambulance service.
    c. Contractor's home office.
    d. Contractor's emergency after-hours telephone number.
    e. Engineers' offices.
    f. Owner's office.
    g. Principal subcontractors' field and home offices.

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

3. The Contractor shall provide a telephone in their facility with an adequate speaker phone for use on conference calls. This system may be used for weekly conference calls/project progress meetings.

J. Electronic Communication Service: Provide a computer in the primary field office adequate for use by Engineer and Owner to access project electronic documents and maintain electronic communications.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
2. Maintain support facilities until Engineer schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, with prior consent from the Owner and under conditions acceptable to Owner.

B. Temporary Roads: Access to the site shall be permitted by the Owner. The Contractor shall not construct any staging areas, haul roads, and access roads without the approval of the Owner.

1. Contractor to maintain clear access roadways and walkways necessary for the daily operation and maintenance of the plant. All road closures, trenching/excavation, or other construction activities that may interfere or impede access must be coordinated with and approved by Owner.

2. Where public road(s) pass through the construction area, access to and along this route must be maintained during construction. Contractor shall maintain a graded, non-paved road, to accommodate traffic on the road and allow for construction activities until the permanent road is installed. Contractor is responsible to provide suitable road-grade backfill, graded, for the road. Contractor shall maintain and regrade the road as required to maintain the road in acceptable condition. In addition, contractor shall maintain proper barricades and fencing along this road to secure the construction/staging areas from the public access road. Finally, contractor shall furnish traffic controls along public road as detailed below.

3. Provide dust-control treatment that is non-polluting and non-tracking. Reapply treatment as required to minimize dust.

C. Traffic Controls: Comply with requirements of authorities having jurisdiction and coordinate with the Owner’s Facility personnel.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.
3. Contractor shall provide all lights, signs, barricades, flaggers, and other appurtenances necessary for safety.

D. Parking: Use designated areas of Owner's existing parking areas for construction personnel.

E. Dewatering Facilities and Drains: Comply with all Federal, State, and Local Government requirements. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

F. Project Signs: Provide Project sign. Unauthorized signs are not permitted.

1. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
   a. Provide temporary, directional signs for construction personnel and visitors.

2. Maintain and touchup signs so they are legible at all times.

G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.

H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

I. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

J. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

K. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

G. Site Access: Prior to commencing work the Owner will supply the contractor with access key(s) for the facility front gate. The contractor is responsible to:
   1. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner for any gates, enclosures or fenced areas constructed by the contractor.
   2. The contractor shall be responsible for security of the site during non-working hours of the facility personnel.

H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.

I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

J. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior.

   1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

L. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner and tenants from fumes and noise.

   1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
   2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.

      a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.

3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
4. Insulate partitions to control noise transmission to occupied areas.
5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
6. Protect air-handling equipment.
7. Provide walk-off mats at each entrance through temporary partition.

M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire prevention program.

1. Prohibit smoking in construction areas.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect materials from water damage and keep porous and organic materials from coming into prolonged contact with concrete.

C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Discard or replace water-damaged and wet material.
4. Discard, replace, or clean stored or installed material that begins to grow mold.
5. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.6 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

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

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 015300 – PROTECTION OF EXISTING FACILITIES

PART 1 - GENERAL

1.1 GENERAL

A. The Contractor shall protect all existing utilities, piping and improvements not designated for removal and shall restore damaged or temporarily relocated utilities, piping and improvements to a condition equal to or better than they were prior to such damage or temporary relocation. Where required, existing improvements shall be protected with shoring, sheeting, piles, or other necessary means.

B. The Contractor shall verify the exact locations and depths of all underground piping and utilities shown and not shown and shall make exploratory excavations of all piping and utilities that may interfere with the Work. It shall be the Contractor's responsibility to ascertain the actual location of all existing utilities, piping and other improvements that will be encountered in its construction operations and to see that such utilities or other improvements are adequately protected from damage due to such operations.

C. The Contractor shall notify the Owner’s representative of any change of condition or extra work as soon as it is discovered, including any damage to existing facilities, pipelines and improvements not designated for removal. The Contractor shall also notify the Owner’s representative of any plans to relocate existing piping or facilities to accommodate new construction.

D. Maintaining in Service: All pipelines, electrical, power, telephone, communication cables, gas and water mains shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Engineer are made with the Owner. Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing utility or other improvement the Contractor, after necessary scheduling and approval, shall remove and, without unnecessary delay, temporarily replace or relocate such utility or improvement in a manner satisfactory to the Engineer and the owner of the facility. In all cases of such temporary removal or relocation, the Work shall be accomplished by the Contractor in a manner that will restore or replace the utility or improvement to a new condition meeting the specification requirements.

E. Buried pipelines, utilities, conduits, duct banks, or other improvements that must remain in service and are exposed due to excavation or construction activities shall be protected and supported as required. Segments of pipelines or duct that is suspended over excavated areas shall be temporarily supported until they can be properly backfilled. All temporary support strategies shall be reviewed and approved by Owner and Engineer.

F. All repairs to a damaged utility or improvement are subject to inspection and approval by an authorized representative of the improvement owner before being concealed by backfill or other work.

1.2 RIGHTS-OF-WAY

A. The Contractor shall not do any work or enter upon the rights-of-way of any oil, gas, sewer or water pipeline; any telephone or electric transmission line; any fence; or any other structure, until notified by the Engineer that the Owner has secured authority to do so. After authority has been obtained, the Contractor shall give the governing utility proper advanced notice of its intention to begin work.

1.3 RESTORATION OF PAVEMENT AND SIDEWALKS

A. All paved areas and sidewalks not designated for replacement, cut or damaged during construction shall be replaced with similar materials and of equal thickness to match the existing adjacent undisturbed areas unless otherwise noted. All sidewalks and pavements which are subject to partial removal shall be neatly saw-cut in straight lines. All restoration shall be at the Contractor's expense.

1.4 UNDERGROUND UTILITIES

A. All care shall be exercised to protect existing underground utilities during construction activity. The contractor shall protect pipelines (existing and new) from heavy vehicle loads and ensure that cranes or other heavy outrigging equipment is not parked or stored directly above these utilities without added protection.

B. If the Contractor damages existing utilities, piping or improvements that are not shown or the location of which was not made known to the Contractor prior to excavation and the damage was not due to failure of the Contractor to exercise reasonable care the Contractor shall immediately notify the Engineer. If directed by the Engineer, repairs shall be made by the Contractor under the provisions for changes and extra work contained in the Contract Documents.

1.5 NOTIFICATION BY THE CONTRACTOR:

A. Prior to any excavation in the vicinity of any existing underground facilities, including water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications or telecommunication cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the Contractor shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than three (3) working days prior to excavation so that a representative can be present during such work if they are required to do so.

END OF SECTION 015300

SECTION 015600 – PROJECT ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. The following sections include mitigation measures to be integrated into the project to reduce the potentially environmental impacts resulting from the construction activities. The Contractor shall implement mitigation measures identified below during the construction process, as well as any other measures required in these documents, on the design drawings, and as required by other local, state, and federal agencies.

1.2 WATER QUALITY

A. NPDES Construction Activity Stormwater Permit: Contractor shall comply with the provisions of the NPDES Construction Activity Stormwater permit, including preparation of Notice of Intent to comply with the provisions of this General Permit and preparation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP will identify implementation measures necessary to mitigate potential water quality degradation as a result of construction-related runoff. These measures will include BMPs and other standard pollution prevention actions, such as erosion and sediment control measures, proper control of non-stormwater discharges, and hazardous spill prevention and response. The SWPPP will also include requirements for BMP inspections, monitoring, and maintenance.

B. The following items are examples of BMPs that would be implemented during construction to avoid causing water quality degradation:

1. Erosion control BMPs, such as use of mulches or hydroseeding to prevent detachment of soil, following guidance presented in the California BMP Handbooks – Construction (CASQA 2003). A detailed site map will be included in the SWPPP outlining specific areas where soil disturbance may occur, and drainage patterns associated with excavation and grading activities. In addition, the SWPPP will provide plans and details for the BMPs to be implemented prior, during, and after construction to prevent erosion of exposed soils and to treat sediments before they are transported offsite.
2. Sediment control BMPs such as silt fencing or detention basins that trap soil particles.
3. Construction staging areas designed so that stormwater runoff during construction will be collected and treated in a detention basin or other appropriate structure.
4. Management of hazardous materials and wastes to prevent spills.
5. Groundwater treatment BMPs such that localized trench dewatering does not impact surface water quality.
6. Vehicle and equipment fueling BMPs such that these activities occur only in designated staging areas with appropriate spill controls.
7. Maintenance checks of equipment and vehicles to prevent spills or leaks of liquids of any kind.

1.3 AIR QUALITY

A. Construction Fugitive Dust Control Plan: Contractor shall prepare, submit for review and approval, and implement a dust control plan that conforms to the local requirements. The dust control plan shall include the following dust control procedures, or others as required the local authority:

1. Water all active construction areas at least twice daily, taking into consideration temperature and wind conditions.
2. Cover all trucks hauling soil, sand, and other loose materials or require trucks to maintain at least two feet of freeboard.
3. Pave, apply water three times daily, or apply (non-toxic) soil stabilizers on unpaved access roads, parking areas and staging areas at construction sites.
4. Sweep daily (with water sweepers) all paved access roads, parking areas and staging areas at construction sites.
5. Sweep streets daily (with water sweepers) if visible soil material is carried onto adjacent public streets.
6. Hydroseed or apply (non-toxic) soil stabilizers to inactive construction areas (previously graded areas inactive for ten days or more).
7. Enclose, cover, water twice daily or apply (non-toxic) soil binders to exposed stockpiles (dirt, sand, etc.)
8. Limit traffic speeds on unpaved roads to 5 mph.
9. Install sandbags or other erosion control measures to prevent silt runoff to public roadways, consistent with Mitigation Measures for Erosion Control.
10. Replant vegetation in disturbed areas as quickly as possible.
11. Contractor may use onsite treated effluent for dust abatement. Coordinate access and allowable volumes with Owner.

B. Construction Exhaust Emissions Control Plan: Contractor shall implement an exhaust emissions control plan that shall include the following controls and practices:

1. On road vehicles with a gross vehicular weight rating of 10,000 pounds or greater shall not idle for longer than five minutes at any location as required by Section 2485 of Title 13, Division 3, Chapter 10, Article 1 of the California Code of Regulations. This restriction does not apply when vehicles remain motionless during traffic or when vehicles are queuing.
2. Off road equipment engines shall not idle for longer than five minutes per Section 2449(d)(3) of Title 13, Division 3, Chapter 9, Article 4.8 of the California Code of Regulations. All vehicle operators shall receive a written idling policy to inform them of idling restrictions. The policy shall list exceptions to this rule that include the following: idling when queuing; idling to verify that the vehicle is in safe operating condition; idling for testing, servicing, repairing or diagnostic purposes; idling necessary to accomplish work for which the vehicle was designed (such as operating a crane); idling required to bring the machine to operating temperature as specified by the manufacturer; and idling necessary to ensure safe operation of the vehicle.
3. Off road engines greater than 50 horsepower shall, at a minimum, meet Tier 2 emissions standards. When available, higher Tier engines shall be utilized.

1.4 NOISE

A. Contractor shall develop, submit for review and approval, and implement a Construction Noise Reduction Plan that requires, at a minimum, the following:

1. The contractor shall locate all stationary noise-generating equipment, including hammer bore and drill rigs, as far as possible from nearby noise-sensitive receptors. Stationary noise sources located within 500 feet of noise-sensitive receptors shall be equipped with noise reducing engine housings, and the line of sight between such sources and nearby sensitive receptors shall be blocked by portable acoustic barriers.
2. The contractor shall assure that construction equipment with internal combustion engines have sound control devices at least as effective as those provided by the original equipment manufacturer. No equipment shall be permitted to have an un-muffled exhaust.
3. All construction activities within unincorporated areas shall be limited to between the hours depending upon the jurisdiction.
4. Construction equipment including compressors, generators, and mobile equipment shall be fitted with properly working mufflers.
5. Residences and other sensitive receptors within 200 feet of a construction area shall be notified of the construction schedule in writing, at least two weeks prior to the commencement of construction activities. This notice shall indicate the allowable hours of construction activities as specified by the applicable local jurisdiction or as defined by this mitigation measure. The Owner shall designate a noise disturbance coordinator who would be responsible for responding to complaints regarding construction noise. The coordinator shall determine the cause of the complaint and ensure that reasonable measures are implemented to correct the problem. A contact number for the noise disturbance coordinator shall be conspicuously placed on construction site fences and entrances by the contractor and included in the construction schedule notification sent to nearby residences and sensitive receptors.

1.5 HAZARDS AND HAZARDOUS MATERIALS

A. In the event that evidence of potential soil contamination such as soil discoloration, noxious odors, debris, or buried storage containers, is encountered during construction, the contractor will have a contingency plan for sampling and analysis of potentially hazardous substances, including use of a photoionization detector. The required handling, storage, and disposal methods shall depend on the types and concentrations of chemicals identified in the soil. Any site investigations or remediation shall comply with applicable laws and will coordinate with the appropriate regulatory agencies.

B. If unknown USTs are discovered during construction, the UST, associated piping, and impacted soil shall be removed by a licensed and experienced UST removal contractor. The UST and contaminated soil shall be removed in compliance with applicable county and state requirements governing UST removal.

C. Contractor shall prepare, submit for review and approval, and implement a project-specific Health and Safety Plan that would apply to excavation activities. The plan shall establish policies and procedures to protect workers and the public from potential hazards posed by hazardous materials. The plan shall be prepared according to federal and California OSHA regulations and submitted to the appropriate agency with jurisdiction prior to beginning site activities. The health and safety plan shall also be submitted to the Owner for review and approval.

D. Consistent with the SWPPP requirements, the construction contractor shall be required to implement BMPs for handling hazardous materials onsite. The use of construction BMPs will minimize any adverse effects on groundwater and soils, and will include, but not limited to, the following:

1. Follow manufacturers' recommendations and regulatory requirements for use, storage, and disposal of chemical products and hazardous materials used in construction;
2. Spill control and countermeasures, including employee spill prevention/response training;
3. Avoid overtopping construction equipment fuel gas tanks;
4. During routine maintenance of construction equipment, properly contain and remove grease and oils; and
5. Properly dispose of discarded containers of fuels and other chemicals.

E. The contractor shall follow the provisions of California Code of Regulations, Title 8, Sections 5163 through 5167 for General Industry Safety Orders to protect the project area from being contaminated by the accidental release of any hazardous materials and/or wastes. The local Certified Unified Program Agency (CUPA) will be contacted for any site-specific requirements regarding hazardous materials or hazardous waste containment or handling.

F. Oil and other solvents used during maintenance of construction equipment shall be recycled or disposed of in accordance with applicable regulatory requirements. All hazardous materials shall be transported handled and disposed of in accordance with applicable regulatory requirements.

G. In the event of an accidental release of hazardous materials during construction, containment and clean up shall occur in accordance with applicable regulatory requirements.

H. Contractor shall prepare, submit for review and approval, and implement a Fire Safety Plan for each of the service areas associated with the project. The Fire Safety Plan(s) will describe various potential scenarios and action plans in the event of a fire.

I. During project construction, all staging areas, welding areas, or areas slated for development using spark-producing equipment will be cleared of dried vegetation or other material that could ignite. Any construction equipment that includes a spark arrestor shall be equipped with a spark arrestor in good working order. All vehicles and crews working at the project site(s) will have access to functional fire extinguishers at all times. In addition, construction crews will be required to have a spotter during welding activities to look out for potentially dangerous situations, including accidental sparks.

1.6 CULTURAL RESOURCES

A. Inadvertent Discoveries: If discovery is made of items of historical or archaeological interest, the contractor shall immediately cease all work activities in the area (within approximately 100 feet) of discovery. Prehistoric archaeological materials might include obsidian and chert flaked-stone tools (e.g., projectile points, knives, scrapers) or toolmaking debris; culturally darkened soil ("midden") containing heat-affected rocks, artifacts, or shellfish remains; and stone milling equipment (e.g., mortars, pestles, handstones, or milling slabs); and battered stone tools, such as hammerstones and pitted stones. Historic-period materials might include stone, concrete, or adobe footings and walls; filled wells or privies; and deposits of metal, glass, and/or ceramic refuse. After cessation of excavation the contractor shall immediately contact the NBWRA and the Owner. The contractor shall not resume work until authorization is received from the Owner.

1. In the event of unanticipated discovery of archaeological indicators during construction, the Owner shall retain the services of a qualified professional archaeologist to evaluate the significance of the items prior to resuming any activities that could impact the site.
2. In the case of an unanticipated archaeological discovery, if it is determined that the find is unique under the National Historic Preservation Act (NHPA) and/or potentially eligible for listing in the National Register, and the site cannot be avoided, the Owner shall provide a research design and excavation plan, prepared by an archaeologist, outlining recovery of the resource, analysis, and reporting of the find. The research design and excavation plan shall be submitted to NBWRA and the Owner and approved by the Owner prior to construction being resumed.

B. Discovery of Human Remains: If potential human remains are encountered, the Contractor shall halt work in the vicinity of the find and contact the county coroner in accordance with Public Resources Code Section 5097.98 and Health and Safety Code Section 7050.5. If the coroner determines the remains are Native American, the coroner shall contact the Native American Heritage Commission (NAHC). As provided in Public Resources Code Section 5097.98, the NAHC shall identify the person or persons believed to be most likely descended from the deceased Native American. The most likely descendent makes recommendations for means of treating or disposing of, with appropriate dignity, the human remains and any associated grave goods as provided in Public Resources Code Section 5097.98.

1.7 EXPLOSIVES AND BLASTING:

A. The use or storage of explosives on the Work or site will not be permitted.

1.8 SANITATION

A. The Contractor shall provide approved fixed or portable chemical toilets wherever needed for its employees. The Contractor shall establish regular intervals of collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of in a manner satisfactory to the Engineer and in accordance with all laws and regulations pertaining thereto. The Owner's toilet facilities shall not be used by the Contractor.

END OF SECTION 015600

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 016100 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. General Conditions

1.2 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number, manufacturer name, or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.3 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable

product request within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Section 013300 "Contractor Submittals."
b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Contractor Submittals." Show compliance with requirements.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

B. To the greatest extent possible for each unit of work, the Contractor shall provide products, materials or equipment from a single source.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

D. Fabricated structural components shall be stored on supports above ground and in a manner to prevent accumulation of water and warping. Products subject to deterioration from atmospheric conditions shall be covered in a manner that will provide adequate ventilation to avoid condensation.

E. Products, materials and equipment not stored in a manner that will insure the maintaining of a new condition will be rejected by the Engineer. Such rejected products, materials and equipment shall be immediately removed from the Work site.

1.6 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. Refer to other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:

1. Where Specifications name a product or manufacturer as the “Basis-of-Design”, provide product(s) as listed or by the manufacturer listed. Where Specifications include a list of available products or manufacturers, followed by the phrase “or equal,” provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer subject to requirements of General Conditions.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016100

SECTION 016600 – EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 - GENERAL

1.1 GENERAL

A. Equipment testing and facility startup are required for satisfactory completion of the contract and shall be scheduled and completed within the contract time.

1.2 EQUIPMENT TESTING

A. The Contractor shall provide the services of an experienced and authorized representative of the manufacturer of each item of equipment indicated in the equipment schedules who shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The Contractor shall have the manufacturer's representative revisit the Work site as often as necessary until any and all problems are corrected. The Contractor shall require that each manufacturer's representative furnish to the Engineer a written report addressed to the Owner certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts and has been operated satisfactorily under full-load conditions.

B. The Contractor shall be responsible for scheduling all operations testing. The Contractor shall furnish all personnel, power, water, chemicals, fuel, oil, grease and all other necessary equipment, facilities and services required for conducting the tests. The Contractor is advised that the Engineer and the Owner's operating personnel will witness operations testing and that the manufacturer's representative shall be required to instruct the Owner's operating personnel in correct operation and maintenance procedures. This instruction shall be scheduled with the Engineer and the Owner at least ten (10) days in advance and shall be provided while the equipment is fully operational. The Contractor shall have previously furnished the technical manuals required under Section 013300 entitled, "Contractor Submittals".

1.3 PLANT STARTUP

A. The startup of the facilities and equipment is a coordinating operation requiring the combined technical expertise of the Contractor, suppliers, Engineer and the Owner. The Contractor shall provide the effective coordination of all parties necessary for successful facilities and equipment startup.

B. The Contractor shall be required to startup and operate the various pieces of equipment in accordance with requirements of section 17500 “Commissioning”.

C. All defects in materials or workmanship which appear during this test period shall be immediately corrected by the Contractor. The Contractor shall provide the services of authorized representatives of the manufacturer, in addition to those services required under equipment testing, as may be necessary, to correct faulty equipment operation. Time lost for equipment repairs, wiring corrections, control point settings or other reasons which actually interrupt the startup may, at the discretion of the Engineer, be justifiable cause for extending the startup test duration.

END OF SECTION 016600

SECTION 017324 - SEISMIC RESTRAINT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Seismic restraint systems for mechanical and electrical equipment other than tanks, vessels, bins, hoppers, cooling towers, freestanding signs, or storage racks.

1. For seismic restraint of tanks, vessels, bins, hoppers, cooling towers, freestanding signs or storage racks, refer to specifications for those sections.

B. Refer to structural Plans for project-specific seismic design criteria.

1.2 RELATED WORK

A. Section 013300: Submittal Procedures

B. Section 016100: Product Requirements

1.3 SYSTEM DESCRIPTION

A. Furnish and install complete seismic restraint systems, including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer’s installation requirements and compliance with applicable building, mechanical, and electrical codes and standards.

B. Provide restraint systems, hangers, supports, bracing and anchorage in all directions for piping, ductwork, conduits, cable trays, panels, equipment and other items at risk of seismic damage.

1.4 REFERENCES

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
1. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures Chapter 13 and Chapter 15
2. California Building Code (CBC) Chapter 16 “Structural Design” or
3. International Building Code (IBC) Chapter 16 “Structural Design”
4. MSS SP127 Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
5. SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems

1.5 SUBMITTALS

A. To avoid repetitive submittals, seismic restraint submittals will not be accepted for review until dimensional drawings for supported equipment have been accepted by the Engineer and returned to Contractor.

B. Furnish the following submittals:

SUBMITTAL	DESCRIPTION	
Shop Drawings	Submit per structural Shop Drawing requirements. Show equipment dry weights and locations of centroids Show applicable wet weights using specific gravities of fluids proposed for use Provide loading diagram showing static loads and forces imparted to surrounding pipes and structures. Show auxiliary equipment mounting slides and rails Show snubbers and vibration isolators. Show anchorage details and quantity, diameter, load rating, edge distances and penetration depths for anchors.	.
Product Data	Submit for pre-manufactured systems per Product Data requirements.	
Engineering Calculations	Submit Engineering Calculations for anchorage of the following Contractor-furnished equipment: 1. Lift Station Pumps 2. Grinder System 3. Emergency Storage Basin Aluminum Cover	
	Submit for seismic anchorage systems and vibration isolators per Engineering Calculations requirements. Refer to California Building Code or International Building Code (IBC) §16 and ASCE 7 for seismic accelerations. Use full equipment wet weight for calculations.	
	Compute shear and tension forces that must be developed by anchor bolts to resist calculated lateral forces and overturning moments. Select anchors to resist computed shear and tension forces.	

C. Refer to Section 013300 for definition of requirements for Shop Drawings, Product Data, and Engineering Calculations.

D. Under California Building Code or International Building Code and ASCE 7 §13.1.4, Engineering Calculations are not required for:

1. Seismic restraint of components weighing ≤20 pounds.

2. Seismic restraint of components mounted ≤4’ above floor level weighing ≤400 pounds.

3. Seismic restraint of piping, utility or distribution systems weighing ≤5 pounds per lineal foot.

E. For wall and slab-mounted equipment, requirement for engineering calculations will be waived if Contractor submits unsealed calculations demonstrating to City’s satisfaction that:

1. Bolting strength in shear for floor-mounted equipment exceeds weight of equipment.

    a. For bolt strengths in shear, refer to CBC Table 1911.2 or ICC data for concrete anchors.

2. Bolting strength in tension for floor-mounted equipment exceeds weight of equipment multiplied by height of equipment divided by twice the width between bolts in narrowest dimension.
    a. For bolt strengths in tension, refer to CBC Table 1911.2 or ICC data for concrete anchors
2. Bolting strength in shear for wall-mounted equipment exceeds 2.3 x weight of equipment.
    a. For Bolt strengths in shear, refer to CBC Table 1911.2 or ICC data for concrete anchors

B. Calculations required for seismic restraint of nonstructural components shall be sealed by California-licensed civil or structural engineer and shall follow ASCE 7 §13.3 where:
1. S_{DS} shall be as shown on Structural Plans or Geotechnical Report.
    a. If not shown, assume $S_{DS}=⅔S_S$
2. a_p and R_p shall be as shown in ASCE 7 Table 13.5-1 or Table 13.6-1 as appropriate.
3. Under ASCE 7, §13.4.2, anchors in concrete and masonry shall be designed for 1.3 times calculated force F_p
4. Where earthquake lateral design loads for nonstructural components are shown on Plans for Contractor's convenience, typically as multiple of wet weight (W) of furnished item shown on Sheet S1, either this conservative Plan value may be used, or more exact value based on exact elevation of furnished item may be used and substantiated by calculation.

C. When anchoring new structures into existing concrete foundations, seismic design of foundation anchors shall provide lugs for at least 2 redundant anchor bolts beyond those required by seismic Engineering Calculations.
1. Place these to accommodate unexpected field conditions, field interferences, pre-existing embedments, or concrete cracking, deterioration, spalling or honeycombing.
2. If field conditions render up to 2 anchor bolts ineffective, up to 2 redundant bolts may be omitted in field.

D. Site conditions and required equipment environmental ratings are:

VARIABLE		**RATED RANGE**
SEISMIC DESIGN CRITERIA		
Site Soils Class		C
Seismic Importance Factor	I	1.25
	I_p	1.5
Mapped Spectral Response Accelerations	S_S	1.701g
	S_1	0.623g
Design Seismic Loads for Equipment and Nonstructural Components Excluding Tanks	Horizontal Loads – Floor Mount	1.0W
	Horizontal Loads – Wall Mount	2.3W
	Horizontal Loads – Ceiling or Roof Mount	1.4W
	Vertical Loads	1.0W

E. Less conservative values for items in table above will be accepted if supported by sealed Engineering Calculations.

1.6 UNIT PRICES

A. Payment for Work in this section shall be included as part of lump-sum or unit-price bid amount for which such Work is appurtenant.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to Section 016100 for basic requirements for products and materials.

B. Pack gaps between seismic anchorage lugs and floors or foundations with grout to inhibit corrosion of bolts in space between lug and floor or foundation.
   1. In areas subject to chemical exposure use appropriate chemical-resistant grout.

C. Provide vibration-isolated equipment with snubbers capable of retaining equipment in its designated location without failure or deformation of snubbers when exposed to vertical or horizontal forces at contact surfaces equal to 100% of operating weight of equipment.
   1. Air gaps between snubber retainer and equipment base shall be ≤¼”.

D. Anchor piping with flexible connection and/or expansion joints so intended uses of these joints are maintained in piping system.

PART 3 - EXECUTION

3.1 PREPARATION

A. Make field measurements needed to install seismic restraint systems before submitting Shop Drawings or ordering.
   1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.

3.2 INSTALLATION

A. Furnish and install seismic restraint systems as required by code and at locations shown on Plans and Submittals.

B. The following installation standards shall be followed:
   1. Manufacturer’s installation and warranty requirements
   2. Applicable OSHA and Cal OSHA regulations
   3. Applicable building, fire, plumbing, mechanical and electrical code requirements

C. Refer variances between above documents and Contract Documents to City’s Representative.

END OF SECTION 017324

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 024116 "Demolition, Salvage and Reconstruction" for disposition of waste resulting from demolition of buildings, structures, and site improvements.
2. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.
3. General Conditions

1.2 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging. The Contractor shall be responsible for the disposal of his own waste. Waste shall daily be cleaned up and piled into proper containers by the Contractor.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

1.3 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 7 days of date established for commencement of the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.

B. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

C. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.5 QUALITY ASSURANCE

A. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.6 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.

PART 2 - EXECUTION

2.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

2. Comply with Section 015000 "Temporary Facilities and Controls" and 015600 “Project Environmental Controls” for controlling dust and dirt, environmental protection, and noise control.

2.2 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Burning of waste materials is not permitted.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

2.3 DISPOSAL OF HAZARDOUS WASTE

A. It is not expected that hazardous materials will be encountered in the Work. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner’s representative.

END OF SECTION 017419

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 017500 – COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This specification discusses pre-commissioning and commissioning activities. Pre-commissioning activities include all the activities associated with the first-time startup of all equipment, instruments, electrical gear and/or process. This includes all checks and tests prior to running equipment including any manufacturers inspections. Commissioning activities include but are not limited to the Functional Acceptance Test (FAT) of equipment and facilities with clean water, operator training and manufactures start up services. The final step in commissioning includes a Reliability Acceptance Test (RAT). This test will require the system to function for an extended period without interruption as listed in Table 2. After the test period is complete, the system will be substantially complete and can be turned over to the Owner for beneficial use.

B. For the purpose of this Project, commissioning will start after Owner's acceptance of Operational Readiness Test (ORT) and the listed requirements in Table 1. Full operational tests that demonstrate functionality and reliability will be done during commissioning. It may be necessary to include the installation of temporary facilities to support testing and the removal of temporary facilities when testing is complete. It is the Contractor's responsibility to execute proper planning, notification and scheduling. The commissioning activities will involve the Owner, Engineer, Construction Manager, Contractor and staff responsible for facility operation. The Contractor will provide a Commissioning Coordinator to lead all commissioning activities.

C. This section identifies the tests and documentation that the Contractor shall be responsible for in order to complete pre-commissioning and commissioning. All pre-commissioning and commissioning work, as described in this section, shall be performed by the Contractor and witnessed by the Owner.

D. Related Requirements:

1. Section 011000 – Summary of Work
2. Section 011002 – Sequence of Operations
3. Section 016600 – Equipment Testing and Plant Startup
4. Section 017823 – Operation and Maintenance Data
5. Section 017839 – Project Record Documents
6. Section 260000 – General Electrical Requirements
7. Section 409000 – Instrumentation Control for Process Systems

1.2 DEFINITIONS

A. Operational Readiness Test (ORT): This test includes all parts of a system to verify they are in working order and functioning properly in the system including, but not limited to verification of proper alignment, pressure tests, rotational checks, control devices, loop checks and other items listed in Table 1. The requirements of the ORT are described in detail in Section 1.3 Pre-commissioning Work.

B. Functional Acceptance Test (FAT): The FAT is used to test the system prior to placing it into service. The test is to prove the system is operational using clean water insuring normal operating requirements. The requirements for the FAT are listed in Section 1.4 Commissioning Work.

C. Reliability Acceptance Test (RAT): The RAT is used to prove the reliability of the system for a duration listed in Table 2. The test is performed under normal facility flows using typical process influent with the assistance of plant operators. The requirements for the RAT are listed in Section 1.4 Commissioning Work. Following successful completion of the RAT, and acceptance of the system by the Owner, the Contractor may apply for substantial completion of the system.

D. Substantial Completion: That date as certified by the Engineer when the construction of the Project or a specified part thereof is sufficiently completed, in accordance with the Contract Documents so that the Project or specified part can be utilized for the purposes for which it is intended. The Contractor may apply for Substantial Completion after the Engineer has accepted all Reliability Acceptance Tests (RATs) in accordance with technical specifications section 017500 - Commissioning and the Contractor has submitted all Manufacturers' Certificates of Proper Installation and all Operation and Maintenance Manuals have been submitted and have been approved by the Engineer.

E. Final Completion: Includes all Work under the Contract as outlined in the contract documents, including any approved change orders.

F. System: A system means the overall process, or a portion thereof, that performs a specific function.

G. Commissioning Coordinator: The Commissioning Coordinator is employed by the Contractor and responsible for all commissioning activities, scheduling start-up and training sessions, developing and submitting all reports and certificates. The Commissioning Coordinator shall have no other responsibilities during commissioning and will be on site during all commissioning phases. The Commissioning Coordinator shall be an individual with a minimum of 10 years of experience in construction and commissioning of similar facilities. The Commissioning coordinator's experience shall include at least five (5) projects of similar size and nature in the last 10 years in a role of commissioning coordinator.

H. Owner: Owner is defined as the City of Beaumont. The term Owner also includes the Owners representatives, which includes the Construction Manager, Engineer and Facility Operations Staff.

1.3 PRE-COMMISSIONING WORK

A. Pre-commissioning is made up of all the activities that shall be completed before the Contractor is permitted to begin Commissioning. Table 1 illustrates some of the tasks.

B. The primary activities for this are construction, factory testing, documentation, component testing, stand-alone equipment testing, and energization of electrical power distribution equipment. This also includes pipe pressure testing. The intent is to test isolated equipment and components. Pre-commissioning testing shall conclude with the Owner's acceptance of the Operational Readiness Tests.

C. Once all components have been tested individually, electrical power distribution equipment has been functionally tested and energized, and Owner has accepted all required deliverables, the Contractor may request to proceed to Commissioning. If the Owner agrees that the Contractor has successfully performed all tests and provided all required documentation, the Owner will notify the Contractor in writing that he may begin Commissioning.

1.4 COMMISSIONING WORK

A. Commissioning is composed of two parts, Phase 1 and Phase 2 (note that terms Phase 1 and Phase 2 are not associated with construction phasing and are solely used to describe commissioning requirements). Table 1 illustrates some of the tasks.

1. Phase 1 Commissioning will include operator training as well as comprehensive testing with clean water. The steps will include approval of Operational Readiness Tests and the Functional Acceptance Test (FAT). The purpose of the FAT is to test all equipment, instruments and software as an integrated system using plant water wherever applicable. The successful completion of the Functional Acceptance Test will allow the Contractor to request Operational Acceptance. When all deliverables have been accepted and operator and maintenance training is complete, Owner will notify the Contractor in writing that the facility has achieved Operational Acceptance and he may proceed to the next phase of Commissioning.
2. Phase 2 Commissioning is designed to functionally test the facility as an integrated system under normal operating conditions using wastewater. The testing includes the Reliability Acceptance Test (RAT) that will be conducted over a period of time that demonstrates the operational reliability of the system. (See Table 2 for test durations.) After successful completion of the RAT and all Manufacturers’ Certificates of Proper Operation have been submitted to Engineer, and after the Contractor has submitted all Operation and Maintenance Manuals, the Contractor may request the Owners’ acceptance that the system is Substantially Complete.

1.5 MANUFACTURER'S FIELD SERVICES

A. It is the Contractor’s responsibility to provide the services of the manufacturer’s representatives that apply during equipment installation, facilities testing, pre-commissioning, commissioning and training of the Owner’s personnel. Where manufacturer’s services are specified, the Contractor shall furnish a qualified representative of the manufacturer to provide these services.

B. Contractor shall be responsible to coordinate and/or provide manufacturer’s representative services For Owner Selected or Owner-Furnished equipment.

C. Definitions: For purposes of furnishing manufacturers’ services, the following definitions shall apply:

1. Manufacturer’s Representatives: Employee of manufacturer who is factory trained and knowledgeable in technical and operational aspects of their products and systems.
2. Person-Day or Instructor-Day: One person for eight (8) hours straight time, exclusive of Saturdays, Sundays or holidays; does not include travel time.

D. Submittals

1. Submittals shall be in accordance to General Requirements Section 013300 entitled "Contractor Submittals" and the requirements of this section.
2. Qualifications and experience records of proposed manufacturers' representatives who will assist installation and testing of equipment and conduct training sessions.
3. After installation, each manufacturer's representative shall submit to the Owner, via the Construction Manager, a written report (Certificate of Proper Installation) certifying that the all equipment is installed properly, in accordance with the manufacturer's installation instructions.
4. During Phase 2 of Commissioning and after the RAT, each manufacturer's representative shall submit to the Owner a written report (Certificate of Proper Operation) certifying that the all equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated per specifications.

E. Scheduling of Manufacturer's Field Services

1. The manufacturer's representative shall be an experienced, competent, and an authorized representative of the manufacturer of each item of equipment for which field services are indicated in the individual sections of the Contract Specifications. He shall visit the site of the Work to inspect, check, adjust if necessary, and accept the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is being tested and placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected.
2. The scheduling of all visits to the site by the manufacturer's field services representative shall be determined by the Contractor and accepted by Owner. It is intended that the manufacturers' representatives' visits be for making equipment inspections and normal adjustments, and not for remedying defective work.
3. Manufacturers' representatives shall resolve assembly or installation problems attributable to or associated with, their products and equipment.
4. During the testing, the manufacturer's representative shall assist, as applicable, to perform initial equipment and system adjustments and calibrations.
5. After all acceptance tests have been completed, but prior to Substantial Completion, the Contractor shall recheck all equipment for proper alignment and adjustment, check oil levels, re-lubricate all bearing and wearing points, and, in general, assures that all equipment is in proper condition for regular continuous operation.

PART 2 - PRODUCTS

2.1 COMMISSIONING PLAN

A. The Commissioning Coordinator shall be responsible for preparing the Commissioning Plan.

B. As a condition precedent to receiving any progress payment for work 30 days prior to the pre-commissioning activities, the Commissioning Coordinator shall submit and receive the Owner's acceptance for all commissioning plan documents. The Owner shall require five (5) copies to review the submitted commissioning plan. The commissioning plan shall be submitted 60 days preceding commissioning of a system.

C. Once the Owner has accepted the Commissioning Plan, the Commissioning Coordinator shall reproduce the plans in sufficient number for the Commissioning Coordinator’s purposes and an additional five (5) copies for delivery to the Owner. No test work shall begin until the Commissioning Coordinator has delivered the specified number of final commissioning plans to the Owner.

D. Testing

1. The Contractor shall develop and produce the ORTs, FATs and RATs to conduct the testing. Sample templates for ORT, FAT and RAT have been provided in Exhibit 1 – Commissioning Document Samples of this specification to help facilitate this production.
2. The Contractor shall submit an EPSET procedure, as defined in Section 2.2.B.1 entitled EPSET - Electrical Power System Energization Test.
3. The Commissioning Coordinator shall develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this Contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number each device or control station to be manipulated or observed during the test procedure. The specific results to be observed or obtained shall be identified in the plan. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, Subcontractors' and manufacturers' representatives to be present and expected test duration.
4. The Commissioning Coordinator shall prepare written test procedures for submittal to the owner and Engineer, for acceptance. The test procedures shall be submitted in hard copy and electronically as needed. For each test, the procedure form should clearly define the following:
    a. Test Number
    b. Purpose of the test: Describe what is being verified by this particular test.
    c. Test Method: Describe the setup for the test and the steps required to complete the test.
    d. Criteria: Describe the criteria for passing or failing the test.
    e. Provide space on the form for the Owner’s comments and for individual sign-off.
    f. Test on a loop-by-loop basis. Every loop shall be signed off individually.
    g. Provide a test schedule.
    h. Provide a list of all test equipment to be available for the tests.
    i. Provide a block diagram showing the test setup arrangement. The diagram shall illustrate the equipment under test, any special test equipment and indicate equipment interconnections.
5. Staffing for each test identifying roles and responsibilities.
6. For all ORT testing, the Contractor shall use the final project PLC hardware.
7. Instrumentation list with calibration methods and calibration dates.
8. Acceptance criteria required to release equipment and systems for commissioning.
9. Statement of successful test.
10. Forms for each test.

E. Training

1. Identify each operator and maintenance training class.
2. Lesson plan for each class.

F. Schedule: The Commissioning Coordinator shall produce a test and training schedule setting forth the sequence contemplated for performing the test and training work.

1. The schedule shall detail the equipment and systems to be tested, and shall be part of the Contractor's Baseline Construction Schedule.
2. The schedule shall show the contemplated start date, duration of the test and completion of each pre-commissioning and commissioning activity.
3. The test schedule shall be submitted, reviewed, and accepted by the Owner with the Baseline Construction Schedule.
4. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of the Contract Documents.
5. Daily Schedule for Testing
    a. The Commissioning Coordinator shall begin each day of witnessed testing by meeting with the Owner.
    b. The meeting purpose is to review the test schedule, the test results from the previous day, and where applicable, to coordinate the testing schedule with Plant Operations.
    c. Note that the Commissioning Coordinator will need to schedule some testing outside normal working hours because of plant operational requirements. The Commissioning Coordinator may be required to rearrange portions of the testing schedule at short notice to accommodate unanticipated plant conditions such as equipment failure or unusually high sewage flows caused by wet weather.
6. Show all tests with beginning and ending dates. At a minimum, the Commissioning Coordinator will show all ORT, FAT and RAT schedules.
7. Show all operations and maintenance training classes.

2.2 PRE-COMMISSIONING AND COMMISSIONING TESTS

A. The following tests are conducted by the Commissioning Coordinator during Pre-commissioning and Commissioning.

B. Pre-commissioning: The Contractor shall successfully complete each test and receive written confirmation prior to starting any Commissioning Tests.

1. EPSET - Electrical Power System Energization Test – This test is performed after installation of all electrical switchgear systems and MCCs, after completion of NETA testing of the electrical power distribution system and after receipt of vendor certificate of proper installation. An accepted EPSET procedure shall be used to perform this test. The purpose of EPSET is to ensure 480V and greater power distribution is functional and ready for energization during commissioning. Prior to energization, PLC I/O check will not be possible; it will be part of ORTs and FAT testing. The Contractor cannot power any equipment i.e. lighting panel, PLC panels, etc. until EPSET is complete. Arc Flash labels shall be placed on electrical equipment prior to start of EPSET.
    a. This test will check and document that all local manual, remote and automatic interlocks, switching scenarios, I/O and controls are functional; any temporary power for testing of breakers, switchgear and battery charger system (125 V dc), if required, shall be provided. The Owner's personnel will witness this test. Qualified Contractor and vendor personnel capable of operating and troubleshooting electrical equipment shall be available during the course of this test. The Contractors' Commissioning Coordinator shall direct test.

b. The Contractor shall submit an EPSET procedure. The EPSET procedure shall include the following:
   1) Steps to test and check all modes of operation (local, remote, manual, automatic and PLC), verify all required switching scenarios and functions, and verify that precluded switching scenarios do not occur,
   2) Methodology for supplying temporary power (if required)
   3) Steps to coordinate administrative control of project electrical equipment that interfaces with existing electrical equipment to ensure that testing does not negatively affect Plant operations.

c. Prior to commencement of the EPSET, the following documentation shall be submitted and made available to the Owner:
   1) An accepted EPSET procedure
   2) All associated redlined as-built single line and loop drawings
   3) Electrical equipment O&M manuals and schematics
   4) Certificate of Proper Installation
   5) NETA testing reports and required testing outlined in Division 26 – Electrical

d. Prior to commencement of the EPSET, vendor training of personnel for electrical equipment shall be competed.

2. ORT - Operational Readiness Test - This test is performed after installation and calibration of instruments is complete. The test purpose is for the Contractor to check and document the complete control system, including I/O to/from PLC register but excluding the application software is ready for operation. In addition, the equipment shall be tested in local/manual mode for operation and functionality. This test will be required for all electrical, piping and mechanical equipment, including but not limited to, actuated valves and gates, meters, conveyors, blowers, compressors, mixers, screens, motors, boilers, bio-gas handling equipment, pumps and filters. Upon completion of the test, the Contractor shall leave the equipment de-energized.

   a. After the equipment supplier has certified proper installation, Contractor shall submit printouts for VFD, RVSS, relays and similar parameter settings for review by the Owner prior to starting the ORT. If further tuning is required when equipment is under load, as during FAT or RAT, the Contractor shall arrange to have on site the Supplier to finalize settings. When complete, the Contractor shall provide printouts of parameter settings and submit to the Owner. The final parameter settings shall be included in the Final Vendor Equipment Manual submittal. The Owner shall witness all ORT's. After the ORT's for a system is complete and approved by the Owner the commissioning can begin.

C. Commissioning

1. Phase 1. FAT – Functional Acceptance Test – The FAT is a combined effort between the Contractor and Owner. The combined software/hardware system is tested from this point forward. This test shall be conducted for LOCAL control; REMOTE MANUAL control; REMOTE AUTO control; REMOTE CASCADE (if applicable) control. The purpose for the test is to insure that the PLC and Operator Graphics software configuration is working in conjunction with the hardware and plant as intended. This test is accomplished with the system online under normal operating conditions. Equipment will operate with plant water. After acceptance of the FAT by the Owner, the Contractor may request to start with Phase 2.

2. Phase 2. RAT – Reliability Acceptance Test – The Purpose for this test is for the Contractor to demonstrate that all systems are capable of operating continuously in the intended manner for an extended period without failing. During the RAT, the Contractor will be

responsible for recording all readings, collecting all samples and conducting laboratory analysis. During the RAT, the system under test will be operated within design parameters reflecting the day-to-day operation of the facilities for an uninterrupted period. The duration for each system is listed in Table 2. Several systems may have to test simultaneously in order to treat the wastewater adequately. Each system will require its own RAT, but all of the above systems must start up together. The existing systems must remain operational during the test in case of a problem during the test period.

3. Unless noted otherwise in Table 2 of this section, the RAT will run for **7** continuous days without interruption. During the test, operation of the system will be under the direction of the Contractors Commissioning Coordinator with assistance from Equipment Manufacturers, Sub-Contractors, Owner and Plant Operators. The test, to the greatest extent possible, will take place at 80% of design flow for each process or piece of equipment. The test may need to be terminated due to above average rainfall, unforeseen conditions at the plant or any malfunction with the equipment causing the plant not to meet its discharge requirements. The Plant must be able to return to normal operation prior to the test if suspension of the test in necessary.
4. If the system test is suspended for a period over, 4 hours due to equipment malfunction or break down, the, the entire test will be void and will need to start at the beginning of the test period.

2.3 PRE-COMMISSIONING AND COMMISSIONING DOCUMENTATION

A. Pre-commissioning: The following documentation shall be up to date and accepted by the Owner prior to starting any Commissioning activities. The Owner will give written notice to the Contractor when all the documents are accepted.

1. Equipment Submittal Process Complete.
2. RFIs and Responses up to Date.
3. All Electrical Equipment Tests.
4. All Process and Instrumentation Equipment Tests.
5. All Mechanical Equipment Tests.
6. Loop Drawings.
7. P&ID Drawings.
8. Contractor Lock-out Tag-out Procedures.
9. All Vendor and Manufacturer Certificates of Correct Installation.
10. All Pressure Test Reports.
11. All Loop Test Reports.
12. All Conductivity Test Reports.
13. All Instrument Calibration Reports, including parameter settings for magnetic flow meters, ultrasonic level elements, transmitters and similar instruments requiring calibration.
14. All Electrical Breaker Setting Reports.
15. All Mechanical Alignment Reports.
16. Draft Operations and Maintenance Manual.
17. Any and All Operating Permits.
18. Operator Training Plan.
19. Pre-commissioning Report.

B. Commissioning: The following documents shall be submitted by the Commissioning Coordinator to Owner during commissioning:

1. Redline As-Built Drawings.
2. Final Maintenance Manuals.
3. Final Punch List.
4. Commissioning – Phase 1 Report.
5. Commissioning – Phase 2 Report.

2.4 DOCUMENTATION

A. The Commissioning Coordinator shall develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.

B. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test, and signature spaces for Owner's witness and the Contractor. A separate file shall be established for each system and item of equipment. For process systems that require commissioning prior to taking another process system out of service, the documentation shall be provided for each process system to be completed independently. These files shall include the following information as a minimum:

1. Metallurgical tests (If applicable).
2. Factory performance tests.
3. Accelerometer recordings made during shipment.
4. Field calibration tests.
5. Field pressure tests.
6. Field performance tests.
7. Field operational tests.

C. The Commissioning Coordinator shall develop test documentation forms specific to each item of equipment and system installed under this Contract.

D. Once the Owner has reviewed and taken no exception to the forms proposed by the Commissioning Coordinator, the Commissioning Coordinator shall produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this Contract.

E. Reference Documentation

1. The Commissioning Coordinator shall make two sets and a digital file of the following documentation available to the Owner or its representatives, at the test site:
   a. All drawings, specifications, addenda and change-orders;
   b. Copy of the accepted test procedure for the specific equipment being tested and record keeping forms filled out during testing.

2.5 REPORTS

A. The Contractor shall submit several reports to the Owner for acceptance in order to continue with the Commissioning process. For process systems that require commissioning prior to taking another process system out of service the reports shall be submitted for each process system as completed. These shall be submitted in hard copy and electronic format. The reports are described below. One each of these tests is required even though not specifically listed in the detailed specification section.

B. Pre-commissioning Report: The Pre-commissioning Report is a collection of all test reports, test data, certificates and commissioning forms that are produced during the Pre-commissioning Stage. The first section of this document will be a summary of the contents certifying that all prescribed tests and procedures have been successfully completed. The Commissioning Coordinator is responsible for producing this document.

C. Commissioning – Phase 1 Report

1. The Phase 1 Report is a collection of all test reports, test data, certificates and commissioning forms that are produced during the Phase 1 Stage. The first section of this document will be a summary of the contents certifying that all prescribed tests and procedures have been successfully completed. The Commissioning Coordinator is responsible for producing this document.

D. Commissioning – Phase 2 Report

1. The Phase 2 Report is a collection of all test reports, test data, certificates and commissioning forms that are produced during the Phase 2 Stage. The first section of this document will be a summary of the contents certifying that all prescribed tests and procedures have been successfully completed. The Commissioning Coordinator is responsible for producing this document.
   a. Manufacturer's equipment data.
   b. Field recorded dimensional measurements and clearances.
   c. Pressure, pressure differential, level, flow and other field settings.
   d. All electrical devices field settings.
   e. Operational pressure tests, control system timing tests and settings and other test data specified.
   f. Field wiring changes made, including marked up drawings.

2.6 SUBMITTALS

A. Contractor shall submit the following information in addition to specific equipment where specified in individual sections and paragraphs:

1. Manufacturer’s Certification of Proper Installation of all equipment.
2. Completed ORT, FAT and RAT forms.

B. Submit design and details of temporary test equipment and facilities.

C. Formal Reports

1. Submit two (2) bound copies and one (1) digital file of all start-up and test reports within thirty days after completion of last test.

PART 3 - EXECUTION

3.1 PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES

A. The following is a partial list of activities that shall be complete during each stage of Commissioning.

B. Pre-commissioning

1. Electrical Service Tie-ins.
2. Electrical Testing.
3. Electrical Equipment is Clean and Energized.
4. Mechanical Equipment is Clean and Energized.
5. Verify Rotation of Motors.
6. Verify Alignment of Equipment.
7. Perform Local Manual Mode Tests.
8. Piping Equipment is Complete and Pressure Tested.
9. Pipe Supports Complete.
10. Pipe is Clean of Debris (inside and out).
11. Verify Valve Operation and Positions for Commissioning.
12. SCADA System is Complete and Energized.
13. Perform Wiring and Loop Tests.
14. PLC Programming Complete.
15. Perform Electrical Power System Energization Test (EPSET).
16. Perform Operational Readiness Test.
17. Pre-commissioning Requirements.

C. Commissioning

1. Operator Training.
2. Prepare As-Built Drawings.
3. Functional Acceptance Test (FAT).
4. Reliability Acceptance Test (RAT).
5. Prepare Final Maintenance Manuals.
6. Complete Final Punch List.

TABLE 1
PRE-COMMISSIONING AND COMMISSIONING

<table>
<tr><th rowspan="2">PRE-COMMISSIONING</th><th colspan="2">COMMISSIONING</th></tr>
<tr><th>PHASE 1</th><th>PHASE 2</th></tr>
<tr><td>Equipment Submittal Process Complete</td><td rowspan="2">Redline As-Built Drawings Received Prior to Operator Training</td><td rowspan="2">Reliability Acceptance Test (RAT)</td></tr>
<tr><td>RFI's and Responses up to Date</td></tr>
<tr><td>All Electrical Equipment Tests Complete</td><td rowspan="2">Operational Readiness Tests Reports Approved</td><td rowspan="2">All Manufactures Certificates of Proper Installation and Training</td></tr>
<tr><td>All Process and Instrumentation Tests Complete</td></tr>
<tr><td>All Mechanical Equipment Tests Complete</td><td rowspan="2">Operator Training Completed Prior to Phase 2</td><td>Commissioning - Phase 2 Report</td></tr>
<tr><td>Loop Drawings</td><td rowspan="2">Substantial Completion of System</td></tr>
<tr><td>P&ID Drawings</td><td>Functional Acceptance Test (FAT)</td></tr>
<tr><td>Contractor Safety Procedures in place</td><td>Commissioning - Phase 1 Report</td><td>Final O&M Manuals</td></tr>
<tr><td>Equipment, Valve and Pipe Labeling Complete</td><td rowspan="3">Obtain operational acceptance from the Owner to Proceed to Phase 2</td><td>Final Punch List Complete</td></tr>
<tr><td>All Manufactures Certificates of Proper Installation</td><td>Final As-Built Drawings</td></tr>
<tr><td>All Pressure Test Reports</td><td>Final Completion</td></tr>
<tr><td>All Loop Test Reports</td><td></td><td></td></tr>
<tr><td>All Conductivity and Megger Test Reports</td><td></td><td></td></tr>
<tr><td>All Instrument Calibration Reports</td><td></td><td></td></tr>
<tr><td>All Breaker Setting Reports</td><td></td><td></td></tr>
<tr><td>All Mechanical Alignment Reports</td><td></td><td></td></tr>
<tr><td>Operator and Maintenance Training Plan</td><td></td><td></td></tr>
<tr><td>Commissioning Plan Accepted</td><td></td><td></td></tr>
<tr><td>Draft O&M Manuals Submitted and Approved</td><td></td><td></td></tr>
<tr><td>Electrical Power System Energization Test</td><td></td><td></td></tr>
<tr><td>Operational Readiness Tests (ORT's) Complete</td><td></td><td></td></tr>
<tr><td>Pre-commissioning Report Submitted</td><td></td><td></td></tr>
<tr><td>Obtain Owner Approval to Proceed to Commissioning Phase 1</td><td></td><td></td></tr>
</table>

TABLE 2
RELIABILITY ACCEPTANCE TEST PARAMETERS

SYSTEM	TEST DURATION
Group #1	7 Continuous Days without a problem
Lift Station Pumps #1 and #2	
Grinder System	
Group #2	7 Continuous Days without a problem
Lift Station Pumps #3 and #4	

EXHIBIT 1

COMMISSIONING DOCUMENT SAMPLES

OPERATIONAL READINESS TEST (ORT)

FUNCTIONAL ACCEPTANCE TEST PROCEEDURE (FAT)

SAMPLE RELIABILITY ACCEPTANCE TEST PROCEEDURE (RAT)

OPERATIONAL READINESS TEST
CITY OF BEAUMONT
MESA LIFT STATION UPGRADE

Date:_________________

Equipment Name:_______________________________ Equipment #:____________________________

Test Type:______________________________________ System:_________________________________

Step	ok Contractor	ok Sub	Signature or comments for non-acceptance(Owners Rep) Comment / Sign Off
Verify ready for startup by manufacture if applicable			
Verify correct installation			
Verify correct electrical and control wiring (voltage, breaker settings, etc.)			
Verify all lubrication is complete and correct			
Check rotation (uncouple motor from equipment if required)			
Verify all alarms and signals are functioning (simulate signal if needed)			
Verify all H/O/A switches function			
Verify all emergency stops function			
Check clearances and verify all guards are in place			
Verify loop checks are complete and test operation through the PLC			
Equipment is ready for system Functional Acceptance Test (FAT)			

FUNCTIONAL ACCEPTANCE TEST PROCEDURE (FAT)

1.1 OVERVIEW

A. The purpose of the Functional Acceptance Test (FAT) is to demonstrate to the Owner that both the software and hardware installed under this Contract is performing as specified. The test is performed with the equipment in service using plant water. The FAT is a combined effort between Contractor and Owner. The tests will require coordination with Operations to ensure normal processing is not disrupted. A Plant Operator must be present when any system operated may disrupt normal plant operation. Each individual piece of equipment shall have a completed ORT prior to the system FAT. This schedule will be based on work sequencing as discussed in the Contract Documents.

1.2 TEST PROTOCOL

A. The combined software/hardware system is tested from this point forward. The test is performed with equipment in service under normal operating conditions, and extreme design conditions (max and min), to the extent that test conditions allow. The purpose of the test is to ensure that the PLC and Operator Graphics software configuration is working in conjunction with the hardware and plant as intended.

B. Equipment will operate with plant water. Application software problems encountered during the test will be investigated and corrected by the Contractor. Problems with PLC and/or SCADA software programming done by the Owner will be corrected by the Owner. The Contractor shall provide a qualified person familiar with the installation and trouble-shooting of PLC panels, working full time, under the direction of the Commissioning Coordinator, for the duration of the test. Prior to the test, the Contractor shall submit a written FAT procedure, prepared by the Commissioning Coordinator, to the Owner for approval. The Owner’s approval of the procedure prior to the start of the FAT is required.

C. Alarms and interlocks are simulated in the field by activating the final element (sensor) or where this is not possible, by simulating the test condition at field terminals as close as possible to the final element. Calibration checks completed for the Operational Readiness Test will not be repeated.

D. The Owner must be notified 48 hours prior to the start of the FAT and must be present during the test.

E. Any sections of the test are found to be unsatisfactory; the Contractor will be required to repeat the test at his expense.

1.3 COMPONENTS

A. Each component of a system shall be brought on line as required to simulate a fully functioning system.

B. Each component shall be tested at normal plant flows. If it is not possible to produce the flow, it can be simulated for this testing purpose.

C. Each component shall be fully functional and compatible with the system at the conclusion of the FAT.

D. Any repair or replacement of system components shall be completed and tested prior to final approval and beginning the RAT (Reliability acceptance Test).

1.4 TEST PROCEDURE

A. The Commissioning Coordinator shall prepare a written procedure and sign off sheet for each system. The sheet shall include all necessary components and requirements for the system. The procedure must be submitted to the Owner twenty-one (21) working days prior to the test for approval and comments. The Owner must approve the procedure prior to proceeding with the test.

B. Following is a general procedure for conducting the FAT:

1. Schedule test time with the Owner.
2. Set all valves and gates to the required position.
3. Fill channels and basins with Plant Water to prepare for the startup.
4. Energize electrical equipment.
5. Check and calibrate all transmitters, sensors, alarms and meters.
6. Simulate high, normal and low flow conditions.
7. Verify operation and reporting of the system through the SCADA System as well by manual operation.
8. Obtain approval from the Owner prior to terminating the test.

SAMPLE FUNCTIONAL ACCEPTANCE TEST PROCEDURE EXAMPLE PUMP STATION #1			
#	**Test and Setup**	**Required Results**	**Sign-off / Comments**
1	Verify all ORT's are complete and accepted by Owner	All ORT's complete (Provide copies of all ORT's)	
2	Notify Owner	All required people notified to observe test	
3	Verify all local and remote switches are in the off position	No unwanted starting of equipment	
4	Energize equipment at the MCC and power panel		
Example Pumps #1 through #2			
1	Open isolation valves	Pumps should not operate unless the isolation valves are open.	
2	Verify proper operation of level instruments	Verify the level instruments operate as intended.	
4	Verify downstream processes are ready to receive flow.	Pumps should not be operated unless downstream processes are available to receive flow.	
5	Provide utility water to wet well and fill wet well as needed.	Pumps should not operate without water in the wet well.	
6	Turn HOA switch to Hand	Verify the pump operates and run at appropriate flow/head conditions.	
7	Turn HOA switch to Auto	Pump should not operate until water level is at high level setpoint.	
8	Verify pump alarms along with pump on and pump off sequence with HOA in Auto.	Pump should operate as intended in Auto.	
9	De-energize equipment until Reliability Acceptance Test (RAT)	Contractor lock out tag out procedure	

Test Completion Endorsements			
		Signature/Date (Contractor)	Signature/Date(Owners Rep)
1	All components are complete and functioning.		
2	Acceptance to move on to Reliability Acceptance Test (RAT)		

SAMPLE RELIABILITY ACCEPTANCE TEST PROCEDURE (RAT)
EXAMPLE PUMP STATION #1

1.1 OVERVIEW

A. The RAT for the Example Pump Station #1 will involve other areas or systems that must start simultaneously; they are listed in Sequence of Construction in Section 011000, "Summary of Work" and/or in Section 011002 "Sequence of Operations." Each related area will have its own RAT. The Commissioning Coordinator will be responsible to prepare each RAT and schedule the startup of the systems with the Owner. The RAT cannot begin until the Functional Acceptance Tests (FAT) is complete and passed off by the Owner for all of the related areas.

1.2 CONSTRAINTS

A. The RAT will run for 7 continuous days without interruption or problem (unless a different duration is noted in Table 2 above). During the test, the responsibility for operation of the system and direction for testing falls on the Contractors Commissioning Coordinator with assistance from Equipment Manufacturers, Sub-Contractors, Engineer, Owner and Plant Operators. The test, to the greatest extent possible, will take place at 80% of design flow for each process or piece of equipment. The test may need to be terminated due to above average rainfall, unforeseen conditions at the plant or any malfunction with the equipment causing the plant not to meet its discharge requirements. A contingency plan in case the RAT is suspended must be submitted.

B. If the system test is suspended for a period over 4 hours, due to equipment malfunction or break down, the entire test will be void and will need to start at the beginning of the test period.

C. The RAT must be repeated and run for an additional 7 continuous days without interruption and or problem following the construction and FAT for the Equalization Basin.

1.3 PROCEDURE

A. Prior to beginning the Influent Pump Station RAT, all of the related systems must be ready for their own RAT. These are identified in the Sequence of Construction in Section 011000, "Summary of Work" and/or in Section 011002 "Sequence of Operations." The contractor, with the approval of the Owner, may modify this list of related areas.

B. All ORT's and the FAT must be complete and approved prior to beginning the RAT. Documentation requirements will be discussed with the Commissioning Coordinator and Owner. The Commissioning Coordinator will create the logs, and record the information. The logs will be submitted to the Owner for acceptance at the conclusion of the test and have the logs available for review during the test.

C. A written procedure will be submitted to the Owner 60 days prior to the test for approval and comment. A sample startup activity list for the Influent Pump Station is provided below.

EXAMPLE WET WELL #1 STARTUP ACTIVITY		
1.	Verify completion of ORT’s and FAT.	
2.	Verify the Owner has approved the RAT procedure.	
3.	Verify all downstream systems are ready to accept flow. (See Section 011000 for a list of related systems.)	
4.	Startup meeting with Owner, Plant Operators, Commissioning Coordinator and Engineer reviewing the startup plan.	
Influent Pump Station		
	Downstream Process Equipment should be operating	
1.	Open the appropriate pump isolation valves.	
2.	Energize Pumps #1, #2 and #3	
4.	Set the HOA switch for Pumps #1, #2 and #3 to Auto.	
5.	Open the appropriate isolation valves and/or gates to introduce flow to the wet well.	
6.	Verify the operation of the pump station.	
8.	Start the clock for the RAT.	

DOCUMENTATION

A test and issue log will be the only required documentation for the Influent Pump Station RAT. A sample log sheet is provided below.

EXAMPLE PUMP STATION #1 TEST AND ISSUE LOG										
Activity/Equipment	Start Time/Date	Verify Proper Operation Initial Y=Yes N=No							Stop Time/Date	Comments/Issues (Use additional sheet if needed.)
		S	M	T	W	T	F	S		
Pump #1										
Pump #2										
Pump #3										
Level Sensor #1										
Level Alarm Low										
Level Alarm High										
Level Alarm High/High										
Note:										
Contractor Approval:										
Engineer Approval:										
Owner Approval:										

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Section 017500 “Commissioning” for commissioning requirements.
2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 ACTION SUBMITTALS

A. Product Data: For cleaning agents (submitted by the Contractor)

B. Contractor's List of Incomplete Items: Initial submittal by the Contractor at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal by the Contractor at Final Completion.

1.3 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.4 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include comments from the Construction Manager, Owner and Engineer.
4. Submit list of incomplete items in the following format:

   a. MS Excel electronic file. Engineer will return annotated copy.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 14 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

   1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
   3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number where applicable.

      a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer’s signature for receipt of submittals.

   5. Submit test/adjust/balance records.
   6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 14 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

   1. Advise Owner of pending insurance changeover requirements.
   2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   3. Complete startup and testing of systems and equipment.
   4. Perform preventive maintenance on equipment used prior to Substantial Completion.
   5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video as required.
   6. Advise Owner of changeover in heat and other utilities.
   7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
   8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   9. Complete final cleaning requirements, including touchup painting.

10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 14 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.5 FINAL COMPLETION PROCEDURES

A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
1. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
2. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection to determine acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.6 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or

installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

D. Operating manuals, technical manuals and instructions. The Contractor's attention is directed to the condition that one percent (1%) of the contract price will be deducted from any monies due the Contractor as progress payments if at the seventy-five percent (75%) construction completion point the approved technical manuals have not been submitted in accordance with Section 013300 entitled, "Contractor Submittals". The aforementioned amount will be retained by the Owner as the agreed estimated value of the approved technical manuals. Any such retention of money for failure to submit the approved technical manuals on or before the seventy-five percent (75%) construction completion point shall be in addition to the retention of any payments due to the Contractor as specified in Article 4 of the Contract.

E. Releases from all parties who are entitled to claims against the subject project, property or improvement pursuant to the provisions of law.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

    a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    e. Remove snow and ice to provide safe access to building.
    f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    h. Sweep concrete floors broom clean in unoccupied spaces.
    i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
    k. Remove labels that are not permanent.
    l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
    m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
    n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
    o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
    p. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired.

Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

    a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Product maintenance manuals.
5. Systems and equipment maintenance manuals.

1.2 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.

   a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
   b. Enable inserted reviewer comments on draft submittals.

2. Four (4) paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. One set will be provided to the Engineer and three sets to the Owner.

C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.

1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.

B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

C. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Engineer.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily

navigated file tree. Configure electronic manual to display bookmark panel on opening file.

G. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.

2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

2.3 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.

3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.

F. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: The Contractor shall submit one (1) set of marked-up record prints to the Engineer.

B. Record Specifications: The Contractor shall submit one paper copy of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit one paper copy of each submittal to the Engineer.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised Drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Record data as soon as possible after obtaining it.
   c. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Engineer and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
3. Refer instances of uncertainty to Engineer through Construction Manager for resolution.
4. Engineer will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

   a. Project name.
   b. Date.
   c. Designation "PROJECT RECORD DRAWINGS."
   d. Name of Engineer and Construction Manager.
   e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as paper copy.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as paper copy.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as paper copy.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's and Construction Manager's reference during normal working hours.

END OF SECTION 017839

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 020960 – TEMPORARY BYPASS PUMPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes requirements for implementing a temporary pumping system for the purpose of diverting sewage and process flows around work areas as needed to accomplish the work.

B. The Contractor shall maintain the sewage and process flows through the existing system at all times during construction. Sewage and process flows shall not be allowed to back up and surcharge within the system. To accomplish this, bypass pumping of sewage and process flows may be required by the Contractor. Section 2.3 identifies potential areas of work where temporary bypass pumping may be required. Contractor shall determine where additional bypass pumping associated with the project work is required and shall provide additional bypass pumping at no additional cost to the Owner.

C. The Contractor shall coordinate all bypass pumping work with the Owner or Owner's Representative.

D. If bypass pumping is required or desired, the requirements of this section shall apply.

1.2 QUALITY ASSURANCE

A. Follow national standards and as specified herein.

B. Perform leakage and pressure tests on discharge piping using clean water, before operation. Notify Engineer 24 hours prior to testing.

C. Maintain and inspect temporary pumping system every two hours. The Contractor shall have a responsible operator on site when pumps are operating.

D. Keep and maintain spare parts for pumps and piping on site, as required.

E. Maintain adequate hoisting equipment and accessories on site for each pump.

1.3 SUBMITTALS

A. Submit the following in accordance with Section 013300.

1. Detailed plan and description of proposed pumping system. Indicate number, size, material, location and method of installation of suction and discharge piping, size of pipeline or conveyance system to be bypassed, staging area for pumps, site access point, and expected flow.
    a. Size and location of manhole or access points for suction and discharge hose or piping.
    b. Sections showing suction and discharge pipe depth, embedment, select fill and special backfill, if buried.

c. Temporary pipe supports and anchoring required.
d. Thrust and restraint block sizes and locations.
e. Sewer plugging method and type of plugs.
f. Bypass pump sizes, capacity, number of each size to be on site and power requirements.
g. Backup pump, power and piping equipment.
h. Calculations of static lift, friction losses, and flow velocity. Pump curves showing pump operating range.
i. Design plans and computation for access to bypass pumping locations indicated on drawings.
j. Calculations for selection of bypass pumping pipe size.
k. Method of noise control for each pump and/or generator.
l. Method of protecting discharge manholes or structures from erosion and damage.
m. Schedule for installation and maintenance of bypass pumping lines.
n. Procedures to monitor upstream mains for backup impacts.
o. Procedures for setup and breakdown of pumping operations.
p. Emergency plan detailing procedures to be followed in event of pump failures, sewer overflows, service backups, and sewage spillage.
q. List of equipment for spill containment and cleanup.

2. Maintain copy of emergency plan on site for duration of project.

B. Certify bypass system will meet requirements of codes, and regulatory agencies having jurisdiction.

1.4 CONTRACTORS RESPONSIBILITY FOR OVERFLOWS AND SPILLS

A. Schedule and perform work in manner that does not cause or contribute to incidence of overflows, releases or spills of sewage from sanitary sewer system or bypass operation.

1.5 DELIVERY AND STORAGE

A. Transport, deliver, handle, and store pipe, fittings, pumps, ancillary equipment and materials to prevent damage and following manufacturer’s recommendations.

1. Inspect all material and equipment for proper operation before initiating work.

B. For material found to be defective or damaged due to manufacturer or shipment;

1. When repairable: Repair as recommended by manufacturer.
2. When not repairable: Replace before initiating work.
3. Repair or replacement of defective or damaged material and equipment will be at no cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Discharge and Suction Pipes: Approved by Engineer.

1. Discharge piping: Determined according to flow calculations and system operating calculations.
2. Suction piping: Determined according to pump size, flow calculations, and manhole/structure depth following manufacturer's specifications and recommendations.

B. Polyethylene Plastic Pipe:

1. High density solid wall and following ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-DR) based on Outside Diameter, ASTM D1248 and ASTM D3550.
2. Homogenous throughout, free of visible cracks, discoloration, pitting, varying wall thickness, holes, foreign material, blisters, or other deleterious faults.

C. High-Density Polyethylene (HDPE).

1. Homogenous throughout, free of visible cracks, discoloration, pitting, varying wall thickness, holes, foreign material, blisters, or other deleterious faults.
   a. Defective areas of pipe: Cut out and joint fused as stated herein.
2. Assembled and joined at site using couplings, flanges or butt-fusion method to provide leak proof joint. Follow manufacturer's instructions and ASTM D 2657.
   a. Threaded or solvent joints and connections are not permitted.
3. Fusing: By personnel certified as fusion technicians by manufacturer of HDPE pipe and/or fusing equipment.
4. Butt-fused joint: True alignment and uniform roll-back beads resulting from use of proper temperature and pressure.
   a. Allow adequate cooling time before removal of pressure.
   b. Watertight and have tensile strength equal to that of pipe.
   c. Acceptance by Engineer before insertion.

D. Flexible Hoses and Associated Couplings and Connectors.

1. Abrasion resistant.
2. Suitable for intended service.
3. Rated for external and internal loads anticipated, including test pressure.
   a. External loading design: Incorporate anticipated traffic loadings, including traffic impact loading.
4. When subject to traffic loading, compose system, such as traffic ramps or covers.
   a. Install system and maintain H-20 loading requirements while in use or as directed by the Engineer.

E. Valves and Fittings: Determined according to flow calculations, pump sizes previously determined, and system operating pressures.

F. Plugs: Selected and installed according to size of line to be plugged, pipe and manhole configurations, and based on specific site.

1. Additional plugs: Available in the event a plug fails. Plugs will be inspected before use for defects which may lead to failure.

G. Aluminum "irrigation type" piping or glued PVC piping will not be permitted.

H. Discharge hose will only be allowed in short sections when approved by Engineer.

2.2 EQUIPMENT

A. Pumps.

1. Fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in priming system.
2. Electric or diesel powered.
    a. Diesel powered equipment shall be supplied with hospital grade mufflers for noise suppression. Equipment shall meet air quality exhaust criteria of the local Air Pollution Control District as applicable.
3. Constructed to allow dry running for long periods of time to accommodate cyclical nature of influent flows.

B. Provide.

1. Necessary stop/start controls for each pump.
2. One standby pump of each size maintained on site.
    a. On-line, isolated from primary system by a valve.
3. Quiet flow pumps.

2.3 DESIGN REQUIREMENTS

A. The anticipated flow in areas that may require bypass pumping is given based on historical plant influent and/or process flows. Please note that the plant flows are not constant and vary during any given day and/or season. Bypass pumping will be required to accommodate hourly flow variations based on influent flow received at the treatment facility. Flow areas are given for the following areas where bypass pumping may occur:

1. Bypass Line from Existing MH # 4 to Lift Station Wet Well
    a. Peak Flow = 2,000 gpm (Verify with Engineer prior to completing the bypass pumping system design).
    b. This line will be required during the construction of the new grinder manhole.

B. Provide pipeline plugs and pumps of adequate size to handle peak flow, and temporary discharge piping to ensure total flow associated with structures can be safely diverted around structures to be constructed or modified.

PART 3 - EXECUTION

3.1 PREPARATION

A. Determining location of bypass pipelines.

1. Minimal disturbance to existing utilities and facilities.
    a. Field locate existing utilities in proposed bypass area including convenient points.
2. Obtain Engineer’s approval of location.

3.2 INSTALLATION AND REMOVAL

A. Provisions and requirements must be reviewed by Engineer before starting construction.

B. Construct temporary bypass pumping structures and make connections to existing and/or newly constructed structures requiring bypass pumping and as required to provide adequate suction conduit.

C. Plugging or blocking of sewage flows shall incorporate a primary and secondary plugging device. When plugging or blocking is no longer needed for performance and acceptance of work, remove in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

D. When working inside structure and manholes, exercise caution. Follow OSHA, Local, State and Federal requirements. Take required measures to protect workforce against sewer gases and/or combustible or oxygen-deficient atmosphere.

E. Installation of Bypass Pipelines:

   1. Pipeline may be placed along shoulder of roads and access ways.
   2. If a pipeline must be placed across a roadway and/or access way provide adequate roadway maps suitable for expected traffic loads associated with normal plant operations and construction traffic.
   3. Following Engineer's approval, the contractor may place bypass piping in trenches and cover with temporary pavement.

F. During bypass pumping operation, protect existing utilities and infrastructure from damage inflicted by equipment.

G. Upon completion of bypass pumping operations, and after the receipt of written permission from Engineer, remove piping, restore property to pre-construction condition and restore pavement.

3.3 MEASUREMENT AND PAYMENT

A. Except as otherwise specified herein, providing for and complying with requirements in this Section will not be measured for payment, but cost will be considered incidental to Contract.

END SECTION 020960

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 024100 - DEMOLITION, SALVAGE, AND RECONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall demolish, salvage and reconstruct existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 COORDINATION AND PROJECT CONDITIONS

A. The Contractor shall carefully coordinate the Work in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The Work as indicated is not all inclusive, and the Contractor shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with sequencing requirements in Section 011000 – Summary of Work

B. The Contractor shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. Prior to bidding, the Contractor shall conduct a comprehensive survey at the Site to verify the scope of Work, and the extent of auxiliary utilities. A partial set of record drawings is available for review from the Owner.

C. Buildings and/or structures to be demolished will be vacated and their use discontinued before start of the demolition.

D. Owner assumes no responsibility for buildings and structures to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

E. Hazardous Materials:

1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract or negotiated with the Contractor via a change order.

F. On-site storage or sale of removed items or materials is not permitted.

G. Arrange demolition schedule so as not to interfere with Owner's operations.

H. While demolition and reconstruction are being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes at the existing facility. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the Contractor's employees and the Owner's personnel. The Contractor shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the Engineer.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

C. Pre-demolition Conference: Conduct conference at Project site.

1.5 CONTRACTOR SUBMITTALS

A. Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the Engineer for approval. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

1.6 DEMOLITION AND ABANDONMENT

A. Existing pavement, concrete, retaining walls, curb and gutter, sidewalks, buildings, yard structures, equipment, piping, valves, ductwork, duct banks, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the Work shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the Contractor.

1.7 SALVAGE

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated in the drawings to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location directed by the Engineer. The Contractor shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.

1.8 RELOCATION

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be relocated shall be removed without any degradation in condition from that prior to removal. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

1.9 REHABILITATION

A. Existing lift station site shall be restored and landscaped as noted in the drawings.

1.10 DISPOSAL

A. The Contractor shall be responsible for the legal, offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Inventory and record the condition of items to be removed and salvaged.

3.2 GENERAL

A. The Contractor shall coordinate demolition and reconstruction Work with the Owner and Engineer. Unless otherwise indicated, the Contractor shall be responsible for the sequence of activities. Work shall be performed in accordance with applicable safety rules and regulations.

B. The Contractor shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction. The Owner shall arrange the shutoff of indicated utilities when requested by the Contractor.

C. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the Work activities to the extent indicated. If reconstruction beyond the scope indicated is required, the Contractor shall obtain approval from the Engineer prior to commencing.

3.3 PROTECTION OF EXISTING FACILITIES

A. Before beginning any reconstruction, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to demolition shall be protected and maintained in accordance with Section 015300 – Protection of Existing Facilities. Damaged existing facilities shall be repaired to the previous condition or replaced.

B. Persons shall be afforded safe passages around areas of demolition.

C. Erect a plainly visible fence around drip line of individual trees or around the perimeter drip line of groups of trees to remain.

D. Provide temporary barricades and other protection required to prevent injury to people and adjacent buildings and facilities to remain.

E. Provide protection to ensure safe passage of people around demolition areas.

F. Structural elements shall not be overloaded. The Contractor shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of Work performed under this Section. The Contractor shall remove temporary protection when the Work is complete or when so authorized by the Engineer.

G. The Contractor shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment or material.

H. The Contractor shall not destroy any permanent survey points without the consent and review of the Owner. Any permanent monuments or points destroyed shall be replaced by a licensed land surveyor who is licensed in the State of California. Replacement shall be at the Contractor's expense.

I. All valve boxes, catch basins, manholes, and vaults that are to remain in service shall be adjusted to new grade to coordinate with final grade or pavement.

3.4 DEMOLITION, SALVAGE, AND RELOCATION

A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The Contractor shall verify the scope of the Work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 011000 – Summary of Work. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. Demolish indicated buildings/structures and site improvements completely. Use methods required to complete the Work within limitations of governing regulations.
2. Equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Damage to the existing structure shall be repaired as indicated.
3. Exposed piping including vents, drains, and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2-inches. Resultant openings in the structure shall be repaired as indicated.
4. Electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.
5. Exposed electrical conduits and associated wiring shall be removed. Resultant openings in structures shall be repaired as indicated.
6. Connections to embedded electrical conduits shall be removed a minimum of 2-inches inside the finished surface of the existing structure. Wiring shall be removed and the resulting openings shall be repaired as indicated.

7. Associated instrumentation devices shall be removed.
8. Auxiliary utility support systems shall be removed.
9. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
10. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.
11. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed completely.
12. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 312000 – Earth Moving. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.
13. When existing pipe is removed, the Contractor shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.
14. When existing piping is removed from existing structures, the Contractor shall fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to view, the grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.
15. Electrical reconstruction shall be conducted by the Contractor in a safe and proper manner to avoid injury from electrical shock to the Owner's and Contractor's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections, which are energized or could become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.

B. The Contractor shall perform, in the presence of Owner, an initial and final inspection of existing equipment that will be relocated to ensure the equipment condition is maintained as documented during the initial inspection. The Contractor shall make repairs and modifications necessary to restore the equipment to its original condition at no additional cost to the Owner.

3.5 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the Contractor shall completely remove the abandoned pipe to the points indicated on the plans. For abandoned segments that connect into active segments to remain, piping shall be removed to the connection pint, and stubbed and capped at the connection point.

B. Where removal is deemed unfeasible, the contractor may abandon in place after receiving permission from Owner. In this case, abandoned pipe shall be removed for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inches diameter or greater shall be completely sand-filled prior to closure of the piping ends.

C. Where abandoned underground structures are encountered, the contractor shall remove the abandoned structures to sufficient depth to allow for new underground lines to cross or for new structures/foundations. Extent of removal shall be coordinated with Owner.

3.6 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by Work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by its construction activities.

B. Where new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as indicated or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to provide watertightness around openings so formed. The boxes or cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.

C. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.

D. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

E. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

F. Where existing handrailing is removed, post embedments and anchors shall be removed and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.

G. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 90 00 – Painting and Coating to match the original painting and coating with a compatible system.

3.7 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities, which shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.8 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The Contractor shall comply with government regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.9 CLEANING

A. During and upon completion of Work, the Contractor shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by Work in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the Engineer or governing authorities, and adjacent areas shall be returned to condition existing prior to start of Work.

END OF SECTION 024100

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 032900 – JOINTS IN CONCRETE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall construct all construction joints, expansion joints and control joints in concrete at the locations shown (where not shown the Contractor shall submit joint layout for Engineer's approval) and formed in accordance with the details shown in the drawings.

B. Waterstops shall be provided in all construction and expansion joints of hydraulic or below grade structures unless specifically noted otherwise on the drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-In-Place Concrete. 033000
B. Joint Sealants. 079200

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Federal Specifications:

TT-S-00227E	Sealing Compound, elastomeric type, multi-component (for Caulking, Sealing, Glazing Buildings and Other Structures).

B. Commercial Standards:

ASTM C920	Specification for Elastomeric Joint Sealants.
ASTM D624	Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
ASTM D1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 CONTRACTOR SUBMITTALS

A. Waterstop: Prior to production of the waterstop material required under this Contract, the Contractor shall submit for review complete product data, including qualification samples of extruded sections of each size and shape to be used, catalogue cut, technical data, storage requirements, and splicing methods. The submittal shall also include the manufacturer's certification that the water stop material meets the physical requirements as outlined under paragraph 2.1, herein.

1.5 QUALITY ASSURANCE

A. Waterstop Inspection: Waterstop installation shall be subject to rigid inspection, and no such work shall be scheduled or started without the Contractor having made prior arrangements with the Construction Manager to provide for the required inspections. Not less than twenty-four (24) hours notice shall be provided to the Construction Manager for scheduling such inspections.

B. Waterstop Field Samples: Prior to use of the waterstop material in the field, a sample of a fabricated mitered cross and a tee constructed of each size or shape of material to be used shall be submitted to the Engineer for review. These samples shall be fabricated so that the material and workmanship represent in all respects the fittings to be furnished under this Contract. Field samples of fabricated fittings (crosses, tees, etc.) may be selected at random by the Engineer for testing by a laboratory at the Owner's expense. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

C. All field joints in waterstops shall be subject to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced and all weathered, damaged or otherwise faulty material shall be removed from the site and disposed of by the Contractor at its own expense.

D. Waterstops shall be stored on site where it will not be subjected to freezing temperatures or exposed to the direct rays of the sun.

E. Construction Joint Sealant: The Contractor shall prepare adhesion and cohesion test specimens as specified herein from each shipment of material received at the jobsite. Sealant shall be stored at room temperature and shall not be stored longer than seventy-five percent (75%) of the manufacturer's stated shelf life.

F. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure:

1. Sealant specimen shall be prepared between two concrete blocks (1-inch by 2-inch by 3-inch). Spacing between the blocks shall be 1/2-inch. Coated spacers (2-inch by 1-1/2 inch by 1/2-inch) shall be used to ensure sealant cross-sections of 1/2-inch by 2-inches with a width of 1/2-inch.

2. Sealant shall be cast and cured according to manufacturer's recommendations except that curing period shall not exceed twenty-four (24) hours.

3. Following curing period, the gap between blocks shall be widened to 1-inch. Spacers shall be used to maintain this gap for twenty-four (24) hours prior to inspection for failure.

1.6 GUARANTEE

A. The Contractor shall provide a three (3) year written guarantee of the entire joint sealant and waterstop installations against faulty and/or incompatible materials and workmanship, together with a statement that it agrees to repair or replace, to the satisfaction of the Owner, at no additional cost to the Owner, any such defective areas which become evident within said three (3) year guarantee period.

PART 2 - PRODUCTS

2.1 PVC WATERSTOPS

A. General: Waterstops shall be extruded from an elastomeric plastic compound consisting of virgin polyvinylcloride and additional plasticizers and stabilizers necessary to meet or exceed the requirements and performance criteria of these Specifications and the Corps of Engineers Specifications CRD-C572. No reclaimed scrap or reprocessed material shall be used.

B. Flatstrip, Center-Bulb and Multi-Rib Waterstops: Flatstrip, center-bulb and multi-rib waterstops shall be detailed and as manufactured by: Sika Greenstreak, Vinylex Corp or approved equal; provided, that at no place shall the thickness of flat strip waterstops, including the center-bulb type, be less than 3/8-inch. Prefabricated joint fittings shall be used at all intersections of the ribbed-type waterstops.

C. Other Types of Waterstops: When other types of waterstops not listed above are required and indicated, they shall be subjected to the same requirements as those listed herein.

D. Physical Properties: When tested in accordance with the specified test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Test Method
Tensile Strength-Min (psi)	1750	D 638
Ultimate Elongation-Min (percent)	350	D 638
Low Temp. Brittleness-Max (degrees F)	-35	D 746
Stiffness in Flexure-Min (psi)	400	D 747
Accelerated Aging (CRD-C572)		
Tensile Strength-Min (psi)	1500	D 638
Ultimate Elongation-Min (percent)	300	D 638

2.2 HYDROPHILIC WATERSTOPS

A. Hydrophilic waterstops where shown on the Drawings, shall be Adeka Ultra Seal MC-2010 MN, Greenstreak "Hydrotite" Hydrophilic rubber waterstops or equal. Hydrophilic waterstops shall be installed according to the manufacturer's recommendations.

B. Physical Properties: When tested in accordance with the specified test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property	Value	ASTM TEST Method
Hardness	30	2240
Tensile Strength	100	D412

Elongation %	500	D412
Specific Gravity	1.18	D792

C. Hydrophilic Paste: Where required, use a paste to adhere the waterstop to the surface. Paste shall be Adeka P-201 or equal. Paste shall be applied according to the manufacturer's recommendations.

2.3 JOINT SEALANTS

A. Joint sealant shall be Sikaflex 2c NS or equal. Where sealant is applied in areas to be submerged in liquid, Sikaflex Primer-429 or equal shall be applied first. Contractor shall follow the manufacturer's recommended application methods.

PART 3 - EXECUTION

3.1 GENERAL

A. Unless otherwise shown, waterstops of the type specified herein, shall be fully continuous for the extent of the joint. The Contractor shall take suitable precautions and means to support and protect the waterstops during the progress of the work and shall repair or replace at its own expense any waterstops damaged during the progress of the work.

B. Suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.

C. Splices in waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations. It is essential that the splices have a tensile strength of not less than sixty percent (60%) of the unspliced materials tensile strength and the continuity of the waterstop ribs and of its tubular center axis be maintained.

3.2 INSTALLATION OF WATERSTOP

A. All joints with waterstops involving more than two (2) ends to be jointed together and all joints which involve an angle cut, alignment change or the joining of two (2) dissimilar waterstop sections shall be prefabricated by the Contractor prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.

B. Adequate provisions must be made to support the waterstops during the progress of the work and to ensure the proper embedment in the concrete. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints. The center axis of the waterstops shall be coincident with the joint openings. Maximum density and imperviousness of the concrete shall be ensured by thoroughly working it in the vicinity of all joints.

C. Adequate means shall be provided to prevent waterstops from being folded over by the concrete as it is placed. Unless otherwise shown, all waterstops shall be held in place with light wire ties on

12-inch centers which shall be passed through the edge of the waterstop and tied to the curtain of reinforcing steel. In placing concrete around horizontal waterstops, with their flat face in a horizontal plane, concrete shall be carefully worked under the waterstops so as to avoid the formation of air and rock pockets.

3.3 JOINT CONSTRUCTION

A. Joint Location: Construction joints and control joints shall be provided where shown on Drawings or as approved by the Engineer. Do not eliminate or relocate control joints. Any additional or relocation of construction joints proposed by the Contractor must be submitted to the Engineer for written approval. The location of all joints shall be submitted for acceptance by the Engineer.

B. Construction Joints

1. Locate additional or relocated joints where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. However, if a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footings or floor slabs. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them

2. At all construction joints and at concrete joints indicated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points and side to side) of 1/4-in with chipping tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate the joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 1/8-in thick, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.

3. Unless indicated otherwise, provide joints perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings.

4. Provide waterstops in wall and slab construction joints in liquid retaining structures and at other locations shown on the Drawings.

5. Do not use keyways in construction joints unless specifically shown on the Drawings or approved by the Engineer.

C. Control Joints

1. Make control joints at locations shown on the Drawings. Do not eliminate or relocate control joints.

2. Provide waterstops, sealant grooves, and sealants in wall and slab control joints in liquid retaining structures and at other locations shown on the Drawings.

3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Coat the concrete surface with a bond breaker prior to placing new concrete against it as shown on the Drawings. Do not coat reinforcement or waterstops with bond breaker.

D. Sealant

1. Install sealants in clean dry recesses free of frost, oil, grease, form release agent, loose material, laitance, dirt, dust and other materials which will impair bond at the locations shown on the Drawings. Apply sealant conforming to the manufacturer's recommendations including concrete cure, temperature, moisture, mixing, primer, primer cure time, joint and recess preparation, tooling, and curing. Apply masking tape to each side of the joint prior to the installation of the sealant and remove afterwards along with any spillage to leave a sealant installation with neat straight edges.

2. Sealant grooves shall be formed as shown on the drawings and shall be protected from damage until final application of the sealant. Care shall be taken to prevent chipping of the sealant grove during removal of forms.

E. Special care shall be used in preparing concrete surfaces at joints where bonding between two (2) sections of concrete is required. Unless otherwise shown, such bonding will be required at all horizontal joints in walls and wall to slab joints. Surfaces shall be prepared by sandblasting and washing for removal of laitance or any objectional material. Joints shall be kept clean until the concrete is placed. Vertical joints shall be clean and free of concrete fins, rock pockets or any objectional material.

END OF SECTION 032900

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Sections:

1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

1.2 ACTION SUBMITTALS

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

B. Design Mixtures: Before placing any concrete, the Contractor shall submit to the Engineer, for review, the complete details of all concrete mix designs which he proposes to use including proportions and gradations of all materials for each class and type of concrete specified herein. The mix designs shall be designed by a certified testing laboratory acceptable to the Engineer. The mix design submittal shall also include test results from at least one (1) trial batch of each class and type concrete. From each trial batch six (6) 6-inch X 12-inch test cylinders shall be cast in accordance with ASTM C 31. Three (3) of these cylinders shall be compression tested in accordance with ASTM C 39 at 7-days and the other three (3) at 28-days. Test results shall include full information on each cylinder as to mix and slump in accordance with ASTM C 143. Three (3) drying shrinkage specimens shall also be cast and tested in accordance with ASTM C 157 on each type of structural concrete mix design. All costs for such mix design including mix design tests shall be borne by the Contractor.

C. If fly ash concrete is proposed by the concrete supplier, the Contractor shall submit to the Engineer for review the design mix for fly ash concrete together with the design mix for Portland Cement (non-fly ash) concrete as specified in this Section. The Contractor shall furnish a Certificate of Compliance signed by the supplier identifying the type of fly ash and stating that the fly ash complies with ASTM C 618 and these specifications, together with all supporting test data including a certified chemical and physical analysis report prior to the use of the fly ash the sample represents. The supporting data shall also contain test results confirming that the fly ash in combination with the cement and water to be used meets all strength requirements and is compatible with air-entraining agents and other admixtures.

D. Delivery Tickets: Where ready-mix concrete is used, the Contractor shall provide certified weighmaster delivery tickets at the time of delivery of each load of concrete. Each certificate shall show the total quantities, weight of cement, sand, each class of aggregate, admixtures and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix. Each certificate shall also state the mix number, total yield in cubic yards, the time the batch was dispatched, when it left the plant, when it arrived at the site, when unloading began, and when unloading was finished.

E. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.

F. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

G. Welding certificates.

H. Material certificates.

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.

2. Certify that the Contractor is not associated with the independent testing laboratory proposed for use by the Contractor nor does the Contractor or officers of the Contractor's organization have a beneficial interest in the laboratory.

3. Certify that cement is produced by a manufacturer that does not use hazardous waste derived fuel as an energy source for its kilns.

4. Certificate of conformance for concrete production facilities from the NRMCA.

I. Material test reports.

1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.

2. Cement and fly ash: Conformance to ASTM standards, including chemical analysis and physical tests.

3. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash. Provide for each mix proposed.

a. Standard deviation data for each proposed concrete mix based on statistical records.

Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:

1) Date of sampling and name of testing laboratory.
2) Name of concrete batch plant.
3) Water cementitious ratio.
4) Slump of batch.
5) Air content of batch.
6) 28 day compression test results.
7) If available, temperature and unit weight of batch.

Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.

4. Concrete Mixes: Shrinkage test results for concrete used in hydraulic structures.

J. Floor surface flatness and levelness/slope measurements and wall plumbness measurements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A615/A615M – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
2. ASTM A884/A884M – Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
3. ASTM A1064/A1064M – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
4. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
5. ASTM C33 - Standard Specification for Concrete Aggregates.
6. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
7. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
8. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
9. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
10. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens).
11. ASTM C138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
12. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
13. ASTM C150 - Standard Specification for Portland Cement.
14. ASTM C156 - Standard Test Method for Water Loss (from a Mortar Specimen) Through Liquid Membrane-Forming Curing Compounds for Concrete.

15. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.

16. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.

17. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

18. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.

19. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

20. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

21. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

22. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use in Portland Cement Concrete.

23. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.

24. ASTM C596 - Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.

25. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

26. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.

27. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.

28. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.

29. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).

30. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

B. American Concrete Institute (ACI).

1. ACI 117 – Specification for Tolerances for Concrete Construction and Materials.

2. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

3. ACI 232.2R - Use of Fly Ash in Concrete.

4. ACI 301 – Specifications for Structural Concrete for Buildings.

5. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.

6. ACI 304.2R - Placing Concrete by Pumping Methods.

7. ACI 305R - Hot Weather Concreting.

8. ACI 306R - Cold Weather Concreting.

9. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

10. ACI 347R – Guide to Formwork for Concrete.

11. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.

C. National Ready Mixed Concrete Association (NRMCA)

1. Quality Control Manual, Section 3 - Certification of Ready Mixed Concrete Production Facilities.

D. Truck Mixer Manufacturers Bureau (TMMB)

1. TMMB 100 - Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.

E. Corps of Engineers Specification

1. CRD-C 621-85 Corps of Engineers Specification for Non-Shrink Grout

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Name and address.

2. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.

3. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.

4. Names and qualifications of the supervising laboratory technicians.

5. Statement of conformance provided by evaluation authority defined in ASTM C1077. Provide report prepared by evaluation authority when requested by the Engineer.

6. Submit as required above for other organizations that will provide external technical services.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete."

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

F. Preinstallation Conference: Conduct conference at Project site.

G. Mix design tests on component materials and for compressive strength and shrinkage of concrete shall be performed as specified herein. The mix shall not at any time be changed without approval of the Engineer, except that at all times the batching of fine aggregate shall be adjusted to compensate for the moisture content. Satisfactory means shall be provided at the batching plant for checking the moisture content of the fine aggregate. The details of concrete mixes submitted for approval shall include information on the correction of the batching for varying moisture contents of the fine aggregate.

To avoid unnecessary or haphazard changes in consistency, the aggregate shall be obtained from a source which will ensure a uniform quality.

H. During the progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with the standards of quality specified herein. These tests will be made in accordance with ASTM C 31, ASTM C 39, and ASTM C 157. The testing expense during construction, except for the trial batch or mix design testing, will be borne by the Owner. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall comply with the requirements of the California Building Code (CBC), Section 1903, but shall not be less than one set per day, nor less than one set for each 150 cubic yards of concrete nor less than one set for each 5,000 square feet of surface area for slabs and walls. The costs of additional tests, including non-destructive tests and core drilling, needed to verify or investigate the quality of concrete that is questionable as to meeting the specification, shall be borne by the Contractor.

I. Specimens shall be formed in 6-in by 12-in long non-absorbent cylindrical molds.

1. A “set of test cylinders shall consist of five cylinders; one to be tested at seven days, one to be tested at 14 days, and two to be tested and their strengths averaged at 28 days. The remaining cylinder will be held to verify test results, if needed.

J. Concrete for testing shall be supplied by the Contractor at no cost to the Owner, and the Contractor shall provide assistance to the Owner in obtaining samples and disposal and cleanup of excess material.

K. Evaluation and Acceptance of Concrete:

1. Concrete is expected to reach a higher compressive strength than that which is indicated in Paragraph 2.9, as compressive strength. The strength level of the concrete will be considered satisfactory if the average strength of the two (2) 28-day specimens equals or exceeds the required strength and no individual specimen strength falls below the required strength by more than 500 psi. Where an individual strength test falls below the required strength by more than 500 psi, the Engineer shall have the right to ask for cores taken in accordance with ASTM C 42 and ACI 318, all at the Contractors expense.

2. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.

3. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at the cost of the Contractor.

L. Test slump immediately prior to placing the concrete. Test shall be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.

M. Test for air content shall be conducted on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If aggregates with high absorptions are used, the latter test method shall be used. When concrete is pumped, air content will be determined at point of placement.

N. Shrinkage Tests: Shrinkage tests will be made during construction to ensure continued compliance with these specifications.

O. Ready-mix concrete shall conform to the requirements of ASTM C 94.

P. The Engineer shall have access to and have the right to inspect all batch plants, cement mills and supply facilities providing products under these specifications. Batch plants shall have current certificates that all scales have been tested and are certified within the tolerances as set forth in the National Bureau of Standards Handbook No. 44.

Q. Construction Tolerances: The Contractor shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades or dimensions shown. Where tolerances are not stated in these specifications, permissible deviations will be in accordance with ACI 347. Where tolerances are not met, the concrete shall be repaired or replaced at the Contractor's expense until the tolerances are met.

The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Structural Component	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
Variation from the level or from the grades shown.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
Variation from the plumb.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
Variation in the thickness of slabs and walls.	Minus 1/4-inch; Plus 1/2-inch.
Variation in the locations and sizes of slab and wall openings.	Plus or minus 1/4-inch.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

D. Galvanized-Steel Welded Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from galvanized-steel wire into flat sheets.

E. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1 steel.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II/V, Low Alkali. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class F, including the requirements of Section 2.9 but with the Loss of Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.

   b. Portland Cement shall contain not more than 0.60 percent total alkalies. The term "alkalies" is defined as the sum sodium oxide (Na_2O), potassium oxide (K_2O), calculated as sodium oxide (.658 K_2O). Only one (1) brand of cement shall be used for exposed concrete in any individual structure. The cement shall be suitably protected from exposure to moisture until used. Certified mill test reports for each shipment of cement to be used shall be submitted to the Engineer. Mill test reports shall include the alkali content. Do not use cement produced by a manufacturer that uses hazardous waste derived fuel as an energy source for its kilns.

   c. Do not use air entraining cements.

B. Normal-Weight Aggregates: ASTM C 33, graded.

1. Maximum size aggregate in foundations and mass concrete shall be 1 inch. The maximum size aggregate in slabs on grade, walls, and all other concrete shall be 1 inch.

C. Water: ASTM C 94/C 94M and potable. Water shall be clean and free from objectionable quantities of silty organic matter, oils, chlorides, alkali, salts and other impurities. The water shall be considered potable, for the purpose of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.

2.4 AGGREGATES

A. All concrete aggregates shall be obtained from pits acceptable to the Engineer, shall be <u>non-reactive</u>, sound, uniformly graded and free of deleterious material in excess of allowable limits specified.

B. Combined aggregates shall be well graded from coarse to fine sizes, and be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Lightweight sand for fine aggregate will not be permitted. Aggregates shall conform to ASTM C 33.

1. Coarse Aggregate: Coarse aggregate shall consist of gravel, crushed gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic

matter or other foreign substances. Thin or elongated pieces having a length greater than four (4) times the average thickness shall not exceed fifteen percent (15%) by weight. Deleterious substances shall not be present in excess of the following percentages by weight, and in no case shall the total of all deleterious substances exceed one and one-half percent (1.5%):

2. Fine Aggregate: Fine aggregate for concrete or mortar shall consist of clean, natural sand or a combination of natural and manufactured sands that are hard and durable. Deleterious substances shall not be present in excess of the following percentages by weight of contaminating substances. In no case shall the total exceed three percent (3%):

   Fine aggregate shall not contain strong alkali nor organic matter which gives a color darker than a standard color when tested in accordance with ASTM C 40. Fine aggregate shall have a fineness modulus not less than 2.50 nor greater than 3.00. Except as otherwise specified, fine aggregate shall be graded from coarse to fine in accordance with the requirements of ASTM C 33.

3. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement proposed for the project. If aggregates proposed for use do not meet this requirement, then satisfy either a. or b. below.

   a. Total equivalent alkali content of the cement used shall not exceed 0.6 percent as provided in the Optional Chemical Requirements of ASTM C150.

   b. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement and fly ash proposed for the project. The proportions of the cement-fly ash mix shall be the same as those proposed for the project.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260. Proportion and mix in accordance with manufacturer's recommendations.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

   1. All concrete shall contain five percent (5%), plus or minus one percent (1%) entrained air of evenly dispersed air bubbles at the time of placement. Air entrainment requirement may be modified or waived following an approval from the Engineer for concrete construction not exposed to freeze/thaw cycles. The air-entraining agent shall contain no chloride and conform to ASTM C 260, or U.S. Army Corps of Engineers Specifications CRD-C13. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. The Engineer, or Owner and his duly authorized representatives reserve the right, at any time, to sample and test the air-entraining agent or the air content of concrete received on the job by the Contractor. Air entrainment in the concrete shall be tested by

ASTM C 138, ASTM C 231 or ASTM C 173. If any sample tested does not have the specified air content, a second test shall be performed. If the second test does not meet the specified air content, the concrete represented by the test shall be removed from the job.

2. Retain one or more chemical admixtures from three subparagraphs below.

   a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A. Proportion and mix in accordance with manufacturer's recommendations.
   b. High-Range, Water-Reducing Admixture (Plasticizer): ASTM C 494/C 494M, Type F resulting in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cementitious ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportion and mix in accordance with manufacturer's recommendations.
   c. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixture when so approved.

2.6 SHEET VAPOR RETARDER

A. Provide under building slabs. ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure sensitive tape.

   1. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.
   2. Vaporblock VB10, by Raven Industries,
   3. Or Equal.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

D. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a normal thickness of 6 mils.

E. Water: Potable.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. The curing compound shall contain a fugitive dye so that areas of application will be readily distinguishable. Compound shall contain no wax, paraffin, or oil. Curing compound shall be non-yellowing and have a unit moisture loss no greater than 0.039 gm/cm^2 at 72 hours as measured by ASTM C156. Curing compound shall comply with Federal, State, and local VOC limits.

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.9 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Use fly ash as needed to reduce the total amount of portland cement. Fly ash, as a percent by weight of total cementitious materials, shall not exceed 15 percent.
   1. Class F Fly Ash
      a. Loss on ignition, maximum 1%
      b. SO3 content, maximum 3%
      c. Moisture content, maximum 1%
      d. R = (CaO - 5%)/(Fe2O3), maximum 1.5

C. Admixtures: Use admixtures according to manufacturer's written instructions.

   1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

D. Proportion normal-weight concrete mixture as follows:

   1. Minimum Compressive Strength: 4000 psi at 28 days.
   2. Maximum Water-Cementitious Materials Ratio: 0.45
   3. Minimum Cement W/C per cubic yard (94 lb sacks): 6.0
   4. Slump Limit: 3 inches, plus or minus 1 inch or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
   5. Air Content: 4 percent, plus or minus 1 percent at point of delivery.
   6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
   7. Type of Work: Structural Concrete.

E. Proportion Lean concrete mixture as follows:

   1. Minimum Compressive Strength: 2500 psi at 28 days.
   2. Maximum Water-Cementitious Materials Ratio: 0.60
   3. Minimum Cement W/C per cubic yard (94 lb sacks): 4.5

4. Slump Limit: 3 inches, plus ½ inch or minus 1 inch or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
5. Air Content: 4 percent, plus or minus 1 percent at point of delivery.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Type of Work: Lean Concrete.

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 60 minutes to 45 minutes.

2.12 TRIAL BATCH AND LABORATORY TESTS

A. The Contractor shall take sets of field control cylinder specimens during the progress of the work in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete place each day shall comply with the requirements of the California Building Code (CBC), Section 1903, but shall not be less than one set per day, nor less than one set for each 150 cubic yards of concrete nor less than one set for each 5,000 square feet of surface area for slabs or walls.

B. Before placing any concrete, the Contractor shall submit the certified trial batch results of each class of concrete having a 28-day strength of 4,000 psi or higher, based on the preliminary concrete mixes submitted by the Contractor. All concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the Contractors preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement and admixture proposed for the project. The costs for the trial batch tests shall be borne by the Contractor.

C. Specimens shall be formed in 6-in by 12-in long non-absorbent cylindrical molds.

   1. A “set” of test cylinders shall consist of five cylinders; one to be tested at seven days, one to the tested at 14 days, and two to be tested and their strengths averaged at 28 days. The remaining cylinder will be held to verify test results, if needed.
   2. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional maximum seven-day or 14-day strengths (where proper relation between seven, 14, and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths at no additional cost to the Owner.

D. Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to the Contractor’s testing lab. Protect the specimens against injury or loss through construction operations.

E. Test slump immediately prior to placing the concrete. Test shall be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.

F. Test for air content shall be conducted on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If aggregates with high absorptions are used, the latter test method shall be used. When concrete is pumped, air content will be determined at point of placement.

G. A standard sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements for ASTM C 136. Values shall be given for percent passing each sieve.

2.13 SHRINKAGE LIMITATION

A. 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 ASTM C 157 modified as follows: Specimens shall be removed from molds at an age of 23$\pm$ hours after trial batching, shall be placed immediately in water at 70 degrees F. $\pm$3 degrees F. for at least thirty (30) minutes, and shall be measured within thirty (30) minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F. $\pm$3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7-days. This length at age 7-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 degrees F. $\pm$3 degrees F. and fifty percent (50%) $\pm$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 <u>after</u> 7-days of moist curing.

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 during shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be specified herein.

B. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age and at 28-day drying age, shall be 0.036 percent and 0.042 percent, respectively. The Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements.

C. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than twenty percent (20%).

D. If the required shrinkage limitation is not met during construction, the Contractor shall take all necessary action, at no additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content ratio; washing or aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

2.14 GROUT

A. Grout shall be a mixture of one part Portland cement to 4-1/2 parts sand. Water content shall be such that the grout can be readily spread, yet not wet enough to cause trouble with surface water or laitance, or failure to stay in place after screeding. All grout mixes and mixing procedures shall be submitted in accordance with section 013300-Contractor Submittals, and shall be subject to review and approval by the Engineer prior to commencing the grouting operations.

B. Procedures for grout placement shall be approved by the equipment supplier, to ensure that no equipment is overstressed, as well as proper placement tolerances. Equipment supplier shall have final say on grouting procedures and final tolerances.

PART 3 - EXECUTION

3.1 MIXING CONCRETE

A. Mixing equipment shall be subject to the Engineer's approval. Mixers shall be of the stationary plant or truck mixer type. Adequate equipment and facilities shall be provided for accurate measurement and control of all materials and for readily changing the proportions of the material. The mixing equipment shall be maintained in good working order and shall be capable of combining the aggregates, cement and water within the specified time into a thoroughly mixed and uniform mass and of discharging the mixture without segregation. Cement and aggregate shall be proportioned by weight.

B. The batch plant shall be capable of controlling and delivering of all material to within one percent (1%) by weight of the individual material. If bulk cement is used, it shall be weighed on a separate visible scale which will accurately register the scale load at any stage of the weighing operation from zero to full capacity.

C. Cement shall not come in contact with aggregate or with water until the materials are in the mixer ready for complete mixing with all mixing water. The procedure of mixing cement with sand or with sand and coarse aggregate for delivery to the jobsite for final mixing and an addition of mixing water will not be permitted. Re-tempering of concrete will not be permitted. The entire batch shall be discharged before recharging. The volume of the mixed material per batch shall not exceed the manufacturers rated capacity of the mixer.

D. Each mixer shall be equipped with a device for accurately measuring and indicating the quantity of water entering the concrete, and the operating mechanism shall be such that leakage will not occur when the valves are closed. Each mixer shall be equipped with a device for automatically measuring, indicating and controlling the time required for mixing. This device shall be interlocked to prevent the discharge of concrete from the mixer before the expiration of the mixing period.

E. Transit-mixed concrete shall be mixed and delivered in accordance with ASTM C 94. After the drum is once started, it shall be revolved continuously until it has completely discharged its batch. Water shall not be admitted to the mix until the drum has started revolving. The right is reserved to increase the required minimum number of revolutions allowed, if necessary, to obtain satisfactory mixing, and the Contractor will not be entitled to additional compensation because of such an increase or decrease.

F. Mixed concrete shall be delivered to the site of the work and discharge shall be completed within one (1) hour after the addition of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees F. or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed forty-five (45) minutes. The use of non-agitating equipment for transporting concrete will not be permitted.

G. Truck mixers shall be equipped with counters so that the number of revolutions of the drum may be readily verified. The counter shall be of the resettable type and shall be actuated at the time of starting mixers at mixing speeds. Concrete shall be mixed in a truck mixer for not less than seventy (70) revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

H. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the ¼ and ¾ points of the load during discharge give slumps differing by more than one inch when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump test. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

I. Comply with ACI 318 and ASTM C94.

J. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20-foot long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.

K. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.

3.2 PREPARATION OR SURFACES FOR CONCRETING

A. Earth surfaces shall be undisturbed and/or graded and compacted prior to placing reinforcing as required by the Contract Documents. Earth surfaces shall be thoroughly and uniformly wetted by sprinkling prior to the placing of any concrete. These surfaces shall be kept moist by frequent sprinkling up to the time concrete is placed thereon. The surface shall be free from standing water, mud and debris at the time of placing concrete.

B. The surfaces of all horizontal construction joints shall be cleaned of all laitance, loose or defective concrete and foreign material. Such cleaning shall be accomplished by sandblasting followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.

C. No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel and preparation of surfaces involved in the placing have been completed and accepted by the Construction Manager at least four (4) hours before placement of concrete. All reinforcement, anchor bolts, sleeves, inserts and similar items shall be set and secured in the forms where shown or by shop drawings and shall be acceptable to the Construction Manager before any concrete is placed. Accuracy of placement is the responsibility of the Contractor. All surfaces of embedded items that have become encrusted with dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.

D. All form surfaces in contact with the concrete shall be thoroughly cleaned of all previous concrete, dirt and other surface contaminants prior to use. Damaged form surfaces shall not be used.

Wood form surfaces in contact with the concrete shall be coated with an approved release agent prior to form installation. The release agent shall be non-staining and non-toxic after thirty (30) days. Mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface of steel forms. All steel forms shall have the contact surfaces coated with an approved release agent. The release agent shall be effective in preventing discoloration of the concrete from rust and shall be non-toxic after thirty (30) days.

E. Where concrete is to be cast against old existing concrete, the old concrete shall be thoroughly roughened to exposed, hard aggregate by sandblasting or chipping. Any additional surface preparation shall be as called for in the drawings.

F. 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 diverted out of the forms and clear of the work. No concrete shall be deposited under water or allowed to rise on any concrete until the concrete has attained its initial set. Pumping or other necessary dewatering operations for removing ground water, if required, shall be the responsibility of the Contractor and will be subject to review by the Construction Manager.

G. Pipe, conduit, dowels, sleeves and other ferrous items required to be embedded in concrete construction shall be adequately positioned and supported prior to placement of concrete. There shall be a minimum of 2-inches clearance between embedded items and any of the concrete reinforcement. Securing embedments in position by wiring or welding them to the reinforcement will not be permitted.

3.3 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete except where grating will be installed.

3.4 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

B. Do not embed piping or electrical conduits in concrete unless shown on the Drawings.

C. Pipes and conduits embedded within a slab or wall (other than those merely passing through) shall satisfy the following, unless otherwise shown on the Drawings or approved:

1. Maximum outside dimension of pipe or conduit shall not be greater than one third the overall thickness of the slab or wall.

2. Spacing of pipes or conduits shall be greater than or equal to three diameters or widths on center.

D. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.

E. Fabricate piping and conduit such that the cutting, bending, or relocation of reinforcing steel is not required.

F. Pipe, conduit, dowels, sleeves and other ferrous items required to be embedded in concrete construction shall be adequately positioned and supported prior to placement of concrete. There shall be a minimum of 2-inches clearance between embedded items and any of the concrete reinforcement. Securing embedments in position by wiring or welding them to the reinforcement will not be permitted. Embedded items shall be clean and free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.

G. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

H. Ensure all specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure all mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.

3.5 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.6 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.8 CONCRETE PLACEMENT

A. Placement of concrete shall conform to the requirements and recommendations of ACI 301, 304 and 318, except as modified herein.

B. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

D. Cold-Weather Placement:

1. For this Specification, "cold weather" is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate average daily temperature as the average of the highest and the lowest temperature during the period from midnight to midnight.

2. Batch, deliver, place, cure and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.

3. Review the cold weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during cold weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete and the procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

TABLE 3

Concrete Temperatures
Minimum Dimension of Section

	< 12-in	12 to 36-in
Min. conc temp:	55 Degree F	50 Degree F

5. Protect concrete during periods of cold weather to provide continuous warm, moist curing (with supplementary heat when required by weather conditions) for a total of at least 350 degree-days of curing.

   a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 7 days at an average 50 degrees F = 350 degree-days).

b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.

6. Do not use salt, manure, or other chemicals for protection.

7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, do not expose concrete to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated and air dry concrete for at least 3 days prior to first exposure to freezing temperatures.

8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

E. Hot-Weather Placement:

1. For this Specification, "hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour (lb/sq ft/hr).

2. Batch, deliver, place, cure and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.

a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.

b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.1F. Provide vibration immediately after placement.

c. The Engineer may direct the Contractor to immediately cover concrete with sheet curing material.

3. Review the hot weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during hot weather including production, placement, and curing.

F. No concrete shall be placed without prior inspection of the forms, reinforcing and embedded items and approval from the Construction Manager. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. The Contractor shall notify the Construction Manager at least twenty-four (24) hours in advance of any scheduled concrete placement and shall call for final inspections no later than four (4) hours in advance of the scheduled placement. The Contractor shall notify the Construction Manager at least two (2) hours in advance of setting the opposite side of wall forms so that the construction joint preparation, water stop installation and reinforcing steel inspections can be conducted. It is the Contractor’s responsibility to see that the forms are properly cleaned and oiled before being set, the construction joints properly prepared, reinforcing steel is securely and properly supported in the correct position and that all embedment items including electrical conduit is correctly installed before calling for inspections. The Engineer may at his option require the use of placement cords if deemed necessary.

G. Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these specifications, or which is of inferior quality, shall be removed and replaced at the expense of the Contractor.

H. No concrete shall be placed during rain or snow storms, unless completely covered to prevent storm water from coming in contact with it. Sufficient protective covering material shall be kept on hand at all times should rain or snow storms arise during concrete placement operations.

I. Concrete shall be deposited at or near its final position to avoid segregation caused by rehandling or flowing. Concrete shall not be deposited in large quantities in one place and worked along the forms with vibrator or other means. Concrete shall be uniformly distributed during the placing process and in no case after depositing shall any portion be displaced in the forms more than 2-feet in horizontal direction. Concrete shall be deposited in forms in horizontal layers not to exceed 24-inches in depth and shall be brought up evenly in all parts of the form. The rate of placement of concrete in forms shall not exceed 5-feet of vertical rise per hour. As the concrete is placed it shall be consolidated thoroughly and uniformly by mechanical vibration to secure a dense mass, close bond with reinforcement and other embedded items and smooth surface. The mechanical vibrator shall penetrate not only the freshly placed concrete, but also the previously placed lift to ensure the lifts become monolith. New concrete shall be placed against previously placed concrete, not away from it. When concrete is placed on a slope, placement shall begin at the lower end of the slope and progress to the upper end for the full width of the placement. Consolidation by mechanical vibration shall follow directly behind placement and the rate of placement shall never get ahead of the consolidation crew. Concrete placement shall continue without avoidable interruption, in a continuous operation until the end of the placement is reached.

J. The drop of concrete into slab or wall forms shall be vertical. Concrete shall not be dropped through reinforced steel, but deposited in forms using a hopper with a drop chute to avoid segregation and to keep mortar from coating the reinforcement steel and forms above the in-place concrete. In no case shall the free fall of concrete exceed 4-feet below the end of the hopper or chute.

K. If it takes more than 20-minutes to get back to place concrete over concrete previously placed, the depth of the layers being placed at one time shall be reduced, and/or placing equipment increased, until it is possible to return with the placing operation to previously placed concrete within 20-minutes. If concrete is to be placed over previously poured concrete and more than 20-minutes have elapsed, then a layer of grout not less than 1/2-inch thick shall be spread over the surface before placing the additional concrete.

L. The placement of concrete for slabs, beams or walkways cast monolithically with walls or columns shall not commence until the concrete in the walls or columns has been allowed to set and shrink. The time allowed for shrinkage shall be not less than one (1) hour.

M. Concrete shall be placed with the aid of approved mechanical vibrators. Vibration shall be supplemented by manual forking or spading adjacent to the forms on exposed faced in order to secure smooth dense surfaces. The concrete shall be thoroughly consolidated around reinforcement, pipes or other shapes built into the work. The vibration shall be sufficiently intense to cause the concrete to flow and settle readily into place and to visibly affect the concrete over a radius of at least 18-inches.

Sufficient vibrators shall be on hand at all times to vibrate the concrete as placed. In addition to the vibrators in actual use while concrete is being placed, the Contractor shall have on hand one (1) spare vibrator in serviceable condition. No concrete shall be placed until it has been ascertained that all vibrating equipment, including spares, is in serviceable condition.

Special care shall be taken to place the concrete solidly against the forms so as to leave no voids. Every precaution shall be taken to make all concrete solid, compact and smooth, and if for any reason the surfaces or interiors have voids or are in any way defective, such concrete shall be repaired as directed by the Engineer. No defective work shall be patched or repaired without the prior inspection and approval of the Engineer.

N. The temperature of concrete when it is being placed shall be not more than 90 degrees F. nor less than 40 degrees F. in moderate weather, and not less than 50 degrees F. in weather during which the mean daily temperature drops below 40 degrees F. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F., the Contractor shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The Contractor shall be entitled to no additional compensation on account of the foregoing requirements.

O. Concrete shall not be placed on a frozen subgrade or subgrade that contains frozen materials. All ice and snow shall be removed from inside forms and from reinforcing steel and embedded items. The temperature of all surfaces that the concrete will contact shall be raised above the freezing point for at least 12-hours prior to placing new concrete.

The minimum temperature of fresh concrete as mixed shall be 60 degrees F. for ambient temperature above 30 degrees F.; 65 degrees F. for ambient temperature 0 degrees F. to 30 degrees F.; and 70 degrees F. for ambient temperature below 0 degrees F. The minimum temperature of fresh concrete after placing shall be 55 degrees F. for the first 72-hours.

The use of calcium chloride shall not be permitted.

In general, the Contractor shall adhere to the recommendations as outlined in ACI Standard 306 for cold weather concreting, except as required herein.

3.9 REMOVAL OF FORMS

A. Do not remove forms before the concrete has attained a strength of at least 75 percent of the 28-day specified design strength for beams and slabs and at least 50 percent of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing (whichever is the longer):

TABLE 4

Forms for	Degree Days
Elevated beams and elevated slabs	500
Walls and vertical surfaces	150

Foundation footings and slabs-on-grade	150

(See definition of degree-days in Paragraph 3.8D)

B. Do not remove shores until the concrete has attained at least 75 percent of its specified design strength and also sufficient strength to support safely its own weight and the construction live loads upon it.

C. In cold weather, when temperature of concrete exceeds ambient air temperature by 20 degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities. Fill tie holes and depressions and bug-holes ¼ inch or larger in width or depth with mortar.

1. Apply to concrete surfaces to be covered by backfill or coated with below grade waterproofing systems.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces in water channels, below water surface of basins, inside meter and valve vaults, inside cells of hydraulic splitter boxes and weirs.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete for formed concrete surfaces inside buildings and machine rooms, and for all exposed exterior concrete surfaces of foundations, basins, vaults, hydraulic structures and curbs.

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
4. Formed concrete surfaces inside buildings and machine rooms and all exposed exterior surfaces of foundations, basins, vaults, hydraulic structures and curbs.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture. Surface irregularities shall not exceed ¼ inch.

1. Apply float finish to surfaces indicated and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or floor slabs to be covered with grouted tile or topping grout and slabs to be covered with built-up roofing.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces all building and machine room floors, basin floors not receiving a grout topping, channel floors, top of interior walls, top of interior curbs, steps and walkways.
2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to exterior walkways, curb, gutter, sidewalk and steps, top of valve or meter vaults, electrical pull boxes and catch basins. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. The schedule for finished unformed surfaces shall be as follows:

Unformed Concrete Surface Schedule

Area	Finish

Grade slabs and foundations to be covered with concrete or fill material.	Scratch Finish
Floor slabs to be covered with grouted tile or topping grout and slabs to be covered with built-up roofing.	Float Finish
All building and machine room floors, basin floors not receiving a grout topping, channel floors, top of interior walls, top of interior curbs, steps and walkways.	Trowel Finish
Exterior walkways, curb, gutter, sidewalk and steps, top of valve or meter vaults, electrical pull boxes and catch basins.	Fine-Broom Finish

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

D. Immediately following the first frost in the fall, the Contractor shall be prepared to protect all concrete against freezing.

3.13 CONCRETE SURFACE REPAIRS

A. It is the intent of these Specifications to require quality work including forming, mixture and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.

B. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

C. As soon as the forms have been stripped and the concrete surfaces exposed: Remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

D. Immediately after removal of forms remove tie cones and metal portions of ties. Fill holes promptly upon stripping as follows: Moisten the hole with water, roughen first if necessary for adhesion, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.

E. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Do not damage or stain the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

F. Defective concrete and honeycombed areas: Chip down square and at least 1-in deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8-in wide all around the steel. For areas less than 1-1/2-in deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2-in layers on successive days, each layer being applied (with slurry, etc.) as described above.

G. For very heavy (generally formed) patches, the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

Material	Volumes	Weights
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

H. The Contractor may use a pre-packaged patching compound, such as: Poly-Patch by Euclid Chemical Company; Emaco R310 by BASF Chemical Company; Sikatop 122 Plus by Sika Chemical Corporation or equal only if approved by the Engineer for use and for color match.

3.14 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Air entrainment in the concrete shall be tested by ASTM C 138, ASTM C 231 or ASTM C 173. If any sample tested does not have the specified air content, a second test shall be performed. If the second test does not meet the specified air content, the concrete represented by the test shall be removed from the job.

C. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work. The right of the Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve the Contractor from meeting the requirements of these Specifications.

D. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes with non-shrink grout as specified in Section 036000. The work of cutting, testing and repairing the cores will be at the expense of the Contractor if defective work is uncovered. If no defective work is found, such cost will be at the expense of the Owner.

3.11 FAILURE TO MEET REQUIREMENTS

A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Section 2.9, the Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work. Furthermore, the Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Section 2.9. The cost of such additional curing shall be at no additional cost to the Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner. In such cases of failure to meet strength requirements the Contractor and Owner shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in C94 is the Contractor.

B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In cases where tests of cores fall below the values given in Section 2.9, the Engineer, in addition to other recourses, may require load tests on any one of the slabs, walls, beams, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. All coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner.

C. Should the strength of test cylinders fall below 60 percent of the required minimum 28 day strength, the concrete shall be rejected and shall be removed and replaced at no additional cost to the Owner.

END OF SECTION 033000

SECTION 036000 – GROUTING MORTAR

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, place, finish and cure the following types of grouting mortars as called for herein and as shown in the Contract Documents

B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor

1. Non-Shrink Grout: This type of grout shall be used wherever grout is shown or called for in the Contract Documents, unless another type is specifically referenced.

2. Topping Grout: This type of grout shall be used for concrete fill for built-up surfaces of tank, channel, and basin bottoms.

3. Epoxy Grout: This type of grout shall be used for anchor bolt or reinforcing steel embedment, repairs and resurfacing.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-In-Place Concrete. 033000

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Specifications, codes and standards is listed under Section 033000 entitled, "Cast-In-Place Concrete", and those additional commercial standards as follows:

CRD-C 621	Corps of Engineers Specification for Non-Shrink Grout.
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens).
ASTM C150	Standard Specification for Portland Cement.
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concrete.
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concrete.

ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Testing Agency Evaluation.
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics.
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 CONTRACTOR SUBMITTALS

A. Non-Shrink Grout: Submit manufacturer's catalogue cuts, technical data including compressive strength and expansion data at plastic, flowable and fluid consistencies, storage requirements, product life, working time after mixing, temperature consideration, conformity to the specified ASTM standards, and Material Safety Data Sheets. Also submit manufacturer's applications manual containing instructions and recommendations for mixing, handling, placement and appropriate uses for each type of non-shrink grout used in the work.

B. Topping Grout: Provide certified mix design including type and brand of cement, proportions and gradations of all materials, product data on any proposed admixtures, and compressive strength test results from at least one (1) trial batch. Tests shall be performed by a certified testing laboratory. All costs for such mix design and trial batch tests shall be borne by the Contractor.

C. Non-shrink Epoxy Grout: Submit manufacturer's catalog cuts, technical data including strengths and application manual of instructions for mixing, handling and placing, storage requirements, product life, working time after mixing, temperature consideration, conformity to the specified ASTM standards, and Material Safety Data Sheets.

1.5 QUALITY ASSURANCE

A. Qualifications

1. Grout manufacturers shall have a minimum of 10 years experience in the production and use of the type of grout proposed.

2. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have beneficial interest are not acceptable.

B. Pre-installation Meeting

1. At least ten working days before grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Notify all parties involved with grouting, including the Engineer, of the meeting at least ten working days prior to its scheduled date.

C. Services of Manufacturer's Representative

1. Provide services of a field technician of the non-shrink grout manufacturer who has performed at least five projects of similar size and complexity during the last five years, to attend the pre-installation meeting, to be present for the initial installation of each type of non-shrink grout, and to correct installation problems.

D. Field Testing

1. All field testing and inspection services will be provided by the Owner. Assist in the sampling of materials, and cooperate by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Methods of testing will comply with the applicable ASTM Standards.

2. Field testing of concrete grout will be as specified for concrete in Section 033000.

3. Mix design tests for topping grout shall be performed per the standards referenced herein.

B. During the progress of construction the Engineer may have tests made of each type of grout used in the work to ensure compliance with the Contract Documents. These tests will be made in accordance with the standards referenced herein. The test expense during construction, except for the mix design and trial batch tests, will be borne by the Owner. The costs of additional tests including non-destructive tests and core drilling needed to verify or investigate the quality of questionable work or material shall be borne by the Contractor.

C. Grout for testing shall be supplied by the Contractor at no cost to the Owner.

D. If any grout fails to meet the requirements of these specifications, immediate corrective action shall be taken for all subsequent batches. Grout already in place which fails to meet these requirements is subject to removal and replacement with all costs borne by the Contractor.

E. Construction tolerances shall be as specified in Section 033000 entitled, "Cast-In-Place Concrete", except as modified herein and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.1 NON-SHRINK GROUT

A. Non-shrink grout shall be a prepackaged, inorganic, non-gasliberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer’s instructions shall be printed on each bag or other container in which the materials are packaged.

B. Non-shrink grouts for use as herein specified shall conform to the Corps of Engineers specifications for Non-Shrink Grout, CRD-C621 and to these specifications. The grout shall have a 28-day compressive strength of 6,000 psi or greater.

C. Non-shrink grouts shall be as manufactured by: Tremcrete Systems Incorporated, Woodland, California; Gifford-Hill & Company, Inc., Dallas, Texas; or approved equal.

2.2 TOPPING GROUT

A. Cement topping grout for channels shall be composed of one part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. The minimum compressive strength at 28-days shall be 4,000 psi.

B. Cement grout materials shall be as specified in Section 033000 entitled, "Cast-In-Place Concrete".

2.3 EPOXY GROUT

A. Epoxy grout shall be a pourable, non-shrink, one-hundred percent (100%) 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 non-reactive 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. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application. Manufacturer’s instructions shall be printed on each container in which the materials are packaged.

B. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F. The epoxy grout shall develop a minimum compressive strength of 5,000 psi in 24-hours and 10,000 psi in 7-days.

2.4 CURING MATERIALS

A. Curing materials shall be as specified in Section 033000 entitled, "Cast-In-Place Concrete", for cement topping grout and as recommended by the manufacturer of non-shrink grouts.

PART 3 - EXECUTION

3.1 PLACING NON-SHRINK AND EPOXY GROUT

A. All forming, mixing, surface preparation, handling, placing and consolidated of non-shrink and epoxy grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Curing shall be as specified herein.

END OF SECTION 036000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Shelf angles.
3. Metal ladders.
4. Ladder safety cages.
5. Metal floor plate and supports.
6. Miscellaneous steel trim.
7. Metal bollards.
8. Pipe guards.
9. Abrasive metal nosings, treads, and thresholds.
10. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Metal nosings and treads.
2. Paint products.
3. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Samples for Verification: For each type and finish of extruded nosing and tread.

D. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ladders.

B. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 and Type 316.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

F. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.

G. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

H. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

I. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: As indicated.
2. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B, with G90 coating; 0.108-inch nominal thickness.
3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B; 0.0966-inch minimum thickness; hot-dip galvanized after fabrication.

J. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

K. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

L. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

M. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

N. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).

O. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

P. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

Q. Corrosion Protection: Unless otherwise shown, miscellaneous metalwork of fabricated steel, which will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with Section 098000 "Protective Coatings" and shall not be galvanized prior to coating. All other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.

R. Stainless Steel: Stainless steel metal work shall be of Type 316 stainless steel.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.
3. Provide stainless-steel fasteners for fastening nickel silver.
4. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Except as otherwise specified herein, steel for bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A 307 Grade B, or threaded parts of ASTM A 36 and shall meet the following additional requirements

1. The nut material shall be free-cutting steel.
2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
3. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F 593; with hex nuts, ASTM F 594: and, where indicated, flat washers; Alloy Group 1. Unless otherwise shown or approved, all bolts, anchor bolts, washers and nuts which are buried, submerged or below the top of the wall inside any hydraulic structure shall be of Type 316 stainless steel.

D. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

E. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

F. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

E. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" .

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

C. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended.

D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

E. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 8 inches from ends and corners of units and 24 inches o.c.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

C. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with primer specified in Section 098000 "Protective Coatings."

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.

B. Steel Ladders:

1. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure shall be entirely of Type 316 stainless steel. All other ladders shall be of carbon steel, hot-dip galvanized after fabrication unless noted otherwise on the drawings.
2. Space siderails 18 inches apart unless otherwise indicated.
3. Siderails: As indicated.
4. Rungs: 1/2-inch- diameter steel bars.
5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
6. Provide nonslip surfaces on top of each rung.

2.9 LADDER SAFETY CAGES

A. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.

B. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.

C. Hot-dip galvanize steel ladder safety cages, including brackets and fasteners.

2.10 METAL FLOOR PLATE

A. Fabricate from rolled-stainless-steel floor plate of thickness indicated below:

1. Thickness: As indicated.

B. Provide stainless-steel angle supports as indicated.

C. Provide flush stainless-steel bar drop handles for lifting removable sections, one at each end of each section.

2.11 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

C. Galvanize exterior miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with primer specified in Section 098000 "Protective Coatings."

2.12 METAL BOLLARDS

A. Fabricate metal bollards from 1/4-inch wall-thickness, steel shapes, as indicated.

B. Prime and coat bollards with coatings specified in Section 098000 "Protective Coatings."

C. For removable bollard requirements, see Drawings.

2.13 PIPE GUARDS

A. Fabricate pipe guards from 3/8-inch- thick by 12-inch- wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.

B. Galvanize pipe guards.

C. Prime pipe guards with primer specified in Section 098000 "Protective Coatings."

2.14 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

A. Cast-Metal Units: Cast aluminum, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c.

D. Apply bituminous paint to concealed surfaces of cast-metal units.

E. Apply clear lacquer to concealed surfaces of extruded units.

2.15 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.16 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.17 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

2.18 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 098000 "Protective Coatings" are indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 098000 "Protective Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

B. Anchor bollards in concrete. Fill annular space around bollard solidly with concrete.

C. Anchor bollards in place with concrete footings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

D. Fill bollards solidly with concrete, mounding top surface to shed water.

E. For removable bollard installation requirements see Drawings.

3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 055300 - METAL GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal bar gratings.
2. Formed-metal plank gratings.
3. Metal frames and supports for gratings.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design gratings and grating supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Floors: Uniform load of 125 lbf/sq. ft. or concentrated load of 2000 lbf whichever produces the greater stress.
2. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft.
3. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft.
4. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. or concentrated load of 8000 lbf, whichever produces the greater stress.
5. Unless noted otherwise, deflection of grating shall not exceed ¼” under the loading described above.

C. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Formed-metal plank gratings.
2. Clips and anchorage devices for gratings.
3. Paint products.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Delegated-Design Submittal: Provide design data and analysis signed and sealed by a registered professional engineer in the State of California, responsible for their preparation.

1.4 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual " and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."

PART 2 - PRODUCTS

2.1 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A 510 (ASTM A 510M).

D. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30 (Grade 205).

E. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating.

F. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.

G. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

2.2 ALUMINUM

A. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.4 MISCELLANEOUS MATERIALS

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.5 FABRICATION

A. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

C. Fit exposed connections accurately together to form hairline joints.

D. Fabricate toeplates for attaching in the field.

2.6 METAL BAR GRATINGS

A. Pressure-Locked, Aluminum I-Bar Grating, unless noted otherwise on drawings:

1. Bearing Bar Spacing: 1-3/16 inches
2. Bearing Bar Depth: 2 inch.
3. Bearing Bar Flange Width: 1/4 inch.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Grooved.
6. Aluminum Finish: Class I, clear, anodized finish.

B. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

C. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

D. Do not notch bearing bars at supports to maintain elevation.

2.7 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.

2.8 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

C. Shop prime gratings, frames and supports unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

B. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Attach toeplates to gratings by welding at locations indicated.

D. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055300

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 079200 - JOINT SEALANTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
   1. Exterior joints in the following vertical surfaces and horizontal nontraffic surfaces:
      a. Construction joints in cast-in-place concrete.
      b. Control and expansion joints in unit masonry and cast stone units.
      c. Joints between metal panels.
      d. Joints between different materials listed above.
      e. Perimeter joints between materials listed above and frames of doors and windows.
      f. Control and expansion joints in ceilings and other overhead surfaces.
      g. Other joints as indicated.
   2. Exterior joints in the following horizontal traffic surfaces:
      a. Isolation and contraction joints in cast-in-place concrete slabs.
      b. Tile control and expansion joints.
      c. Joints between different materials listed above.
      d. Other joints as indicated.
   3. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings where indicated.
      c. Tile control and expansion joints.
      d. Vertical joints on exposed surfaces of walls and partitions.
      e. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
      f. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      g. Other joints as indicated.
   4. Interior joints in the following horizontal traffic surfaces:
      a. Isolation joints in cast-in-place concrete slabs.
      b. Control and expansion joints in tile flooring.
      c. Other joints as indicated.

B. Related Sections include the following:
   1. Division 8 Section "Glazing" for glazing sealants.
   2. Division 9 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.
   3. Division 9 Section "Tiling" for sealing tile joints.

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

D. Qualification Data: For Installer.

E. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.

F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

G. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of nonelastomeric sealant and joint substrate indicated.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

E. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:
1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

B. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
   1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
   2. Disintegration of joint substrates from natural causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Immersion in Liquids. Where elastomeric sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247 and qualify for the length of exposure indicated by reference to ASTM C 920 for Class 1 or 2. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

E. Single-Component Neutral-Curing Silicone Sealant:
1. Available Products:
a. Pecora Corporation; 895.
2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 50.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
a. Use O Joint Substrates: Aluminum coated with a high-performance coating.
6. Stain-Test-Response Characteristics: Nonstaining to porous substrates per ASTM C 1248.

F. Single-Component Acid-Curing Silicone Sealant:
1. Available Products:
a. Dow Corning Corporation; 999-A.
b. GE Silicones; Construction
c. Pecora Corporation; 860.
d. Tremco; Proglaze.
2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 25.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
a. Use O Joint Substrates: Aluminum coated with a high-performance coating.

G. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant:
1. Available Products:
a. Pecora Corporation; 898.
b. Tremco; Tremsil 600 White.
2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 25.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
a. Use O Joint Substrates: Ceramic tile.

H. Multicomponent Nonsag Urethane Sealant:
1. Available Products:
a. Pecora Corporation; Dynatrol II.
b. Tremco; Dymeric 511.
2. Type and Grade: M (multicomponent) and NS (nonsag).
3. Class: 50.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.
a. Use O Joint Substrates: Aluminum coated with a high-performance coating.

I. Multicomponent Pourable Urethane Sealant:
   1. Available Products:
      a. Pecora Corporation; Dynatrol II-SG.
      b. Sika Corporation, Inc.; Sikaflex - 2c SL.
      c. Sonneborn, Division of ChemRex Inc.; SL 2.
   2. Type and Grade: M (multicomponent) and P (pourable).
   3. Class: 25.
   4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
   5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

J. Single-Component Nonsag Urethane Sealant:
   1. Available Products:
      a. Pecora Corporation; Dynatrol I-XL.
      b. Sika Corporation, Inc.; Sikaflex - 15LM.
      c. Tremco; DyMonic.
   2. Type and Grade: S (single component) and NS (nonsag).
   3. Class: 25.
   4. Use Related to Exposure: NT (nontraffic).
   5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

2.4 SOLVENT-RELEASE JOINT SEALANTS

A. Acrylic-Based Solvent-Release Joint Sealant: Comply with ASTM C 1311 or FS TT-S-00230.
   1. Available Products:
      a. Tremco; Mono 555.

B. Butyl-Rubber-Based Solvent-Release Joint Sealant: Comply with ASTM C 1085.
   1. Available Products:
      a. Sonneborn, Division of ChemRex Inc.; Sonneborn Multi-Purpose Sealant.
      b. Tremco; Tremco Butyl Sealant.

2.5 LATEX JOINT SEALANTS

A. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.

B. Available Products:
   1. Pecora Corporation; AC-20+.
   2. Sonneborn, Division of ChemRex Inc.; Sonolac.
   3. Tremco; Tremflex 834.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following:
   1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   2. Available Products:

a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

2.7 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F (minus 32 deg C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
   a. Concrete.
   b. Masonry.
   c. Unglazed surfaces of ceramic tile.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.
   c. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.

2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior vertical construction joints in cast-in-place concrete.
1. Joint Sealant: Multicomponent nonsag urethane sealant.
2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

B. Joint-Sealant Application: Exterior horizontal nontraffic and traffic isolation and contraction joints in cast-in-place concrete slabs.
1. Joint Sealant: Multicomponent pourable urethane sealant.
2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

C. Joint-Sealant Application: Exterior vertical control and expansion joints in unit masonry.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

D. Joint-Sealant Application: Exterior butt joints between metal panels.
   1. Joint Sealant: Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

E. Joint-Sealant Application: Exterior vertical joints between different materials listed above.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

F. Joint-Sealant Application: Exterior perimeter joints between unit masonry and frames of doors and windows.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

G. Joint-Sealant Application: Exterior control and expansion joints in ceilings and other overhead surfaces.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

H. Joint-Sealant Application: Vertical control and expansion joints on exposed interior surfaces of exterior walls.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

I. Joint-Sealant Application: Interior perimeter joints of exterior openings.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

J. Joint-Sealant Application: Interior ceramic tile expansion, control, contraction, and isolation joints in horizontal traffic surfaces.
   1. Joint Sealant: Multicomponent nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

K. Joint-Sealant Application: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
  1. Joint Sealant: Single-component mildew-resistant neutral-curing silicone sealant.
  2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

L. Joint-Sealant Application: Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
  1. Joint Sealant: Single-component nonsag urethane sealant.
  2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

M. Joint-Sealant Application: Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
  1. Joint Sealant: Latex sealant.
  2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

END OF SECTION 079200

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 098000 - PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes the surface preparation and application requirements of paint systems as specified herein.

B. The coating system schedule included in the drawings, and the specifications herein identify the surfaces to be coated with the designated coating system number including the required surface preparation, and the products to be applied. If used, coating notes on the Drawings are to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

C. Scope of Work

1. The Contractor shall furnish all materials, labor, equipment, and incidentals required to provide a protective coating system for the surfaces listed herein and not otherwise excluded.
2. The work includes surface preparation and cleaning, painting and finishing of interior and exterior exposed items and surfaces such as ceilings, walls, floors, miscellaneous metal, doors, frames, construction signs, guardrails, posts, pipes, fittings, valves, equipment, and all other work obviously required to be painted unless otherwise specified herein or on the Drawings. The omission of minor items in the schedule of work shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the Specifications as stated herein.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI/NSF Standard 61 Listing of Certified Drinking Water System Components - Health Effects.
2. ANSI Z53.1, Safety Color Code for Marking Physical Hazards.

B. ASTM International (ASTM):

1. ASTM D4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
2. ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages
3. ASTM D4417 – Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel.
4. ASTM D6386 – Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
5. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

6. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

C. International Concrete Repair Institute (ICRI):

1. Guideline No. 310.1 – Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
2. Guideline No. 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealer, Linings, and Polymer Overlays

D. NACE International, (NACE)

1. NACE RP0287 – Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
2. NACE SP0188 – Standard Practice for Discontinuity (Holiday) Testing of Protective Linings
3. NACE No. 1/SSPC-SP 5 - White Metal Blast Cleaning.
4. NACE No. 2/SSPC-SP 10 - Near-White Metal Blast Cleaning.
5. NACE No. 3/SSPC-SP 6 Commercial Blast Cleaning
6. NACE No. 6/SSPC-SP13 – Surface Preparation of Concrete

E. National Association of Pipe Fabricators (NAPF)

1. NAPF 500-03 – Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

F. Occupational Safety and Health Act (OSHA):

1. OSHA 1910.144, Safety Color Code for Marking Physical Hazards.
2. OSHA 1910.145, Specifications for accident prevention signs and tags.

G. SSPC: The Society for Protective Coatings, (SSPC)

1. SSPC PA1 - Shop, Field, and Maintenance Painting of Steel
2. SSPC-PA2 – Paint Application Specification No. 2: Measurement of Dry Coating Thickness with Magnetic Gages.
3. SSPC-PA11 - Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
4. SSPC-SP1 Solvent Cleaning
5. SSPC-SP2 Hand Tool Cleaning
6. SSPC-SP3 Power Tool Cleaning
7. SSPC-SP5/NACE No. 1 – White Metal Blast Cleaning
8. SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning.
9. SSPC-SP 10/NACE No. 2 - Near-White Metal Blast Cleaning.
10. SSPC-SP 13/NACE No. 6 – Surface Preparation of Concrete
11. SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
12. SSPC-VIS 1 - Guide to Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

H. Unless otherwise specified, references to documents shall mean the documents in effect at the time of receipt of Bids. If referenced documents have been discontinued by the issuing organization references to those documents shall mean the replacement documents or the last version of the document before it was discontinued.

1.3 DEFINITIONS

A. "Paint" as used herein means all coating systems, materials, including primers, emulsions, enamels, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

B. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils.

C. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter per pounds per gallon, as determined by EPA Method 24.

D. The term “exposed” as used in this Section shall mean all items not covered with concrete, masonry, or similar material.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

1. Submit to the Engineer as provided in the General Conditions and Section 013300: Contractor Submittals, Working Drawings, and Samples; shop drawings, manufacturer's specifications and data on the proposed paint systems and detailed surface preparation, application procedures and dry film thickness (DFT).
2. Submit material manufacturer's technical information, including paint label analysis and application instructions for each material proposed

a. List each material and cross-reference to specific paint and finish system and application. Identify by manufacturer's catalog number and general classification.
b. Submit copies of manufacturer's complete color charts for each coating system.
c. Provide certifications from manufacturers verifying that factory applied prime coats are compatible with specified finish coatings.
d. Pipe Markers and Safety Signs: Submit copies of manufacturer's technical brochure, including color chart and list of standard signs. Owner will set titles on pipe markers and safety signs.

B. Safety Data Sheets: Copies of current Safety Data Sheets (SDS) for materials.

C. Qualification Data: Submit proof of acceptability of Applicator by manufacturer to Engineer.

D. Jobsite Reports: Submit at the completion of Work
1. Daily Reports: Include surface preparation, ambient conditions, application methods, material applied, material quantities, material batch number, and description of items completed.
2. Applicator shall maintain a copy of records until the expiration of the specified warranty period.

E. Schedule:

1. The Contractor shall submit for approval to the Construction Manager, a complete typewritten Schedule of Painting Operations within 90 days after the Notice to Proceed. This Schedule is

imperative so that the various fabricators or suppliers may be notified of the proper shop prime coat to apply. It shall be the Contractor's responsibility to properly notify and coordinate the fabricator's or suppliers' surface preparation and painting operations with these specifications. Record of notification shall be transmitted to the Construction Manager or be available for review. This Schedule shall include for each surface to be painted, the brand name, generic type, solids by volume, application method, the coverage and the number of coats in order to achieve the specified dry film thickness, and color charts. When the Schedule has been approved, the Contractor shall apply all material in strict accordance with the approved Schedule and the manufacturer's instructions. Wet and dry paint film gauges may be utilized by the Owner to verify the proper application while work is in progress.

2. It is the intent of this section that as much as possible all equipment and piping utilize coating systems specified herein supplied by a single manufacturer. All exceptions must be noted on the Schedule. For each coating system, only one (1) manufacturer's product shall be used.
3. Contractor is responsible for the compatibility of all shop primed and field painted items in this Contract. Furnish information on the characteristics of the finish materials proposed to use, to ensure that compatible prime coats are used. As directed by the Engineer, provide barrier coats over incompatible primers or remove and re-prime. Notify the Engineer in writing of anticipated problems using the coating systems as specified with substrates primed by others.

F. Color Samples: Manufacturer's standard color charts for color selection by Owner.

G. Samples – Painting:

1. Paint colors will be selected by Owner unless other standards are noted. Compliance with all other requirements is the exclusive responsibility of the Contractor.

H. Applicator Qualifications: Submit qualifications as specified under Quality Assurance article.

I. Closeout Submittals:

1. Submit certificate stating Work was properly prepared and painted in accordance with Specifications.
2. Submit manufacturer's certificate stating quantity of paint furnished was sufficient to properly coat all surfaces.
3. Maintenance Manual: Upon completion of work, furnish copies of a detailed maintenance manual including following information:

    a. Product name and number.
    b. Name, address and telephone number of manufacturer and local distributor.
    c. Detailed procedures for routine maintenance and cleaning.
    d. Detailed procedures for light repairs such as dents, scratches and staining.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

A. Provide the best quality grade of the various types of coatings suitable for use in corrosive water and wastewater treatment and pumping environments as regularly manufactured by approved paint materials manufacturers. Materials not displaying the manufacturer's identification as a standard, best grade product will not be acceptable.

B. Provide undercoat paint produced by the same manufacturer as the finish coats. Undercoat and finish coat paints shall be compatible. Use only thinners approved by the paint manufacturer and list the manufacturer, and use only within recommended limits as listed on the manufacturer's product data sheets.

C. Painting shall be accomplished by experienced painters specializing in industrial painting familiar with all aspects of surface preparations and applications required for this project. Work shall be done in a safe and workmanlike manner.

D. Applicator Qualifications:

1. Successfully painted water and wastewater utility installations for at least five (5) years. Submit name and experience record of painting applicator to Engineer. Submit a list of at least five (5) similar installations painted within the last five (5) years, along with responsible officials, architects or engineers involved with the project, and the approximate contract price.
2. Painting applicators whose submissions indicate a lack of experience required to perform the work, or have performed work in an unsatisfactory manner, will not be approved.

E. Pre-Installation Conference:

1. Before start of Work – General Contractor, Applicator, and Manufacturer's Technical Representative shall meet on-site with Engineer to discuss approved products and workmanship to ensure proper surface preparation and application of the coatings.
2. Review foreseeable methods and procedures related to the coating Work including but not necessarily limited to the following:

   a. Review Project requirements and the Contract Documents.
   b. Review required submittals.
   c. Review requirements of on-site quality control inspection and testing.
   d. Review the requirements for preparing the quality control report as specified herein.
   e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
   f. Review material storage and staging.
   g. Review equipment storage and staging.
   h. Review waste management and disposal.
   i. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
   j. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
   k. Review procedures required for the protection of the completed work during the remainder of the construction period.

F. Single-Source Responsibility:

1. Materials shall be products of a single manufacturer or items standard with manufacturer of specified coating materials.
2. Provide secondary materials which are produced or are specifically recommended by coating system manufacturer to ensure compatibility of system.

G. Regulatory Requirements: Conform to applicable codes and ordinances for flame, fuel, smoke and volatile organic compounds (VOC) ratings requirements for finishes at time of application.
   1. The products specified meet the South Coast Air Quality Management District (SCAQMD) Rule 1113.
      a. This area includes all of Orange County, and all the urban areas of Los Angeles, Riverside, and San Bernardino counties.

H. Acceptable Manufacturers:

   1. Tnemec Co. (Where noted otherwise in the coating specification use specified product or equal).
   2. Sherwin Williams, subject to meeting the requirements of individual coating systems requirements and the requirements of an “or equal” product as described below.
   3. Or Equal. No substitutions will be considered that decrease film thickness, number of coats, surface preparation or generic type of coating specified. Furnish same color selection of substituted manufacturers as manufacturer specified, including accent colors in coating systems. Substitutions must meet the performance requirements of the materials selected.

1.7 DELIVERY, HANDLING AND STORAGE

A. Deliver, store and handle paint in accordance with manufacturer's recommendations, and as supplemented below.

B. Delivery of Materials:

   1. Deliver materials to job site in original, new, and unopened packages and containers bearing manufacturer's name and label with following information:

      a. Name or title of material.
      b. Manufacturer's stock number, batch number and date of manufacture (shelf life).
      c. Manufacturer's name.
      d. Contents by volume, for major pigment and vehicle constituents.
      e. Thinning instructions where recommended.
      f. Application instructions.
      g. Color name and number.

C. Storage of Materials:

   1. Store only acceptable project materials on project site.
   2. Store in a suitable location approved by Owner. Keep area clean and accessible.
   3. Restrict storage to paint materials and related equipment.
   4. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970. Flammable materials shall be separated and stored in a suitable area as required.
   5. Keep temperature of storage area above 50° F or manufacturer's recommended storage temperature, whichever is higher. Consult the manufacturer’s written literature for storage condition requirements.

6. Containers shall be clearly marked to indicate any hazards connected with the use of the paint and steps which should be taken to prevent injury to those handling the product.

1.8 JOB CONDITIONS

A. Environmental Requirements:

1. Proceed with coating Work only when temperature of substrate, air temperature, relative humidity, dew point and other conditions comply with the manufacturer's written recommendations and when no damaging environmental conditions are forecasted for the time when the material will be vulnerable to such environmental damage. Record such conditions and include in Daily Report.
2. Maintain substrate temperature and ambient temperature before, during and after installation in accordance with manufacturer's instructions.
3. Provide adequate ventilation during installation and full curing periods of the coating.
4. Coatings shall not be applied when ambient air temperature is within 5°F of the dew point and falling.

B. Dust and Contaminants: Protect work and adjacent areas from excessive dust and airborne contaminates during coating application and curing. Schedule Work to avoid excessive dust and airborne contaminants.

1.9 WARRANTY AND GUARANTEES

A. Unless otherwise noted herein, warranty period shall be 12 months from the date of project substantial completion.

B. All paint and coatings work performed under these specifications shall be guaranteed by the coatings applicator for 100 percent of the total coated area for both materials and labor against failures during the warranty period.

C. Failure under this warranty shall include flaking, peeling, or delaminating of the coating due to aging, chemical attack, or poor workmanship; but it shall not include areas which have been damaged by unusual chemical, thermal, or mechanical abuse.

1.10 SURFACES TO BE COATED

A. Design Requirements:

1. Ensure surfaces are properly prepared, proper primer applied to correct mil thickness, and finish coat is compatible with primer coat and applied to correct mil thickness. This requirement applies to all equipment and material, whether the total process is done in the shop, in the field, or partially in shop and partially in field.
2. Provide paint products supplied by one manufacturer unless otherwise approved by the Engineer.

B. Paint all exposed surfaces, except where natural finish of material is specifically noted as a surface not to be painted.

C. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas.

D. The following items will not be painted unless otherwise noted.

1. Any code-requiring labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.
2. Any moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motor and fan shafts, unless otherwise indicated.
3. Aluminum except where in contact with dissimilar metals.
4. Fiberglass items including but not limited to handrails, walkways, toeboards, windows, louvers, fans, grating, and tanks.
5. Stainless steel, chromium plate/polished chrome, anodized aluminum, nickel and similar finished products.
6. Brass and bronze other than exposed utility tubing.
7. Flexible couplings, lubricated bearing surfaces, insulation and plastic pipe or duct interiors.
8. Plastic switch plates and receptacle plates.
9. Signs and nameplates.
10. Finish hardware.
11. Packing glands and other adjustable parts, unless otherwise indicated.
12. Portions of metal, other than aluminum, embedded in concrete. This does not apply to the back face of items mounted to concrete or masonry surfaces which shall be painted before erection. This also does not apply to concrete encased piping which shall be coated as specified in the Coating Schedule included in the drawings. Aluminum to be embedded in, or in contact with, concrete shall be coated to prevent electrolysis.
13. Galvanized metals unless specifically noted otherwise.
14. Prefinished Items.

    a. Unless otherwise shown or specified, factory finishing such as baked-on factory porcelain, polyvinyl fluoride or other similar finish is specified for such items as, but not limited to, mechanical and electrical equipment such as instruments, light fixtures and distribution cabinets. Touch up factory finished items with paint supplied by the item manufacturer. As directed by Engineer, field paint damaged prefinished items or return them to the factory for repair and repainting.
    b. Any prefinished item not having generic type of paint or proper mil thickness to withstand corrosive atmosphere of water treatment plants, wastewater treatment plants and/or pumping stations shall be returned to the factory for painting or shall have additional coats applied in the field.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The following coating systems list a product by name to establish a standard of quality; other products of the same generic types may be submitted to the Engineer for approval as described in Paragraph 1.6 H., herein. When other than the specified coating system is proposed, the Contractor shall submit on a typewritten list giving the proposed coatings, brand, trade name, generic type and catalog number of the proposed system and the requested test results for the Engineer's approval.

B. Paint used in successive field coats shall be produced by the same manufacturer. Paint used in the first field coat over shop painted or previously painted surfaces shall cause no wrinkling, lifting, or other damage to underlying paint. Shop paint shall be of the same type and manufacturer as used for field painting by the Contractor.

C. Provide paints, pipe marker and safety signs of durable and washable quality. Use materials which will withstand normal washing as required to remove grease, oil, chemicals, etc., without showing discoloration, loss of gloss, staining, or other damage.

2.2 COLORS AND FINISHES

A. Provide surface treatments and finishes as specified in paragraph 2.4 of this Section.

B. Color Schedule: Colors for painted surfaces will be selected by Owner or as shown on Drawings.

C. Piping Color Code: Colors for piping will be in accordance with Section 220553 "Identification for Plumbing Piping and Equipment".

D. Use representative colors when preparing samples for Engineer's review. Final acceptance of colors will be from samples applied on the job.

E. Color Pigments: Pure, nonfading, applicable types to suit substrates and service indicated.

F. Paints specified for application on submerged metal in contact with potable water shall meet NSF 61 and be approved by the governing health and safety codes.

2.3 MANUFACTURERS

A. Products of Tnemec Company, Inc., Kansas City, Missouri are listed to establish a standard of performance and quality.

B. Materials specified are those that have been evaluated for the specific service. Request for material substitutions shall be in accordance with requirements of the project specifications. Equivalent materials of other manufacturers may be submitted on written approval of the Engineer. No request for substitution shall be considered that would decrease film thickness or offer a change in the generic type of coating specified. In no case, will the request be considered unless information is received, in writing, ten (10) days prior to the bid opening date.

C. Requests for substitution shall include:
   1. Manufacturer's literature for each product giving name, product number, generic type, descriptive information, laboratory testing showing results equal to the performance criteria of the products specified herein.
   2. Side by side comparison of the performance attributes of the proposed materials as compared to the specified coating system.
   3. List of ten (10) projects in which each product has been used and rendered satisfactory service.
   4. The sum which will be added to or deducted from the base bid should alternate materials be accepted.

2.4 MATERIALS

A. STEEL – STRUCTURAL, TANKS, PIPE AND EQUIPMENT

1. SYSTEM 101 - EXTERIOR EXPOSED – STRUCTURAL, TANKS, AND EQUIPMENT

   a. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils
   b. Primer: Hydro-Zinc Series 94-H20 2.5 – 3.5 mils dft
   c. Intermediate: Hi-Build Epoxoline II Series L69 at 3.0 – 5.0 mils dft
   d. Finish: Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

2. SYSTEM 102 - EXTERIOR EXPOSED – PIPE

   a. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils
   b. Primer: Hi-Build Epoxoline II Series L69 at 3.0 – 5.0 mils dft
   c. Intermediate: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   d. Finish: Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

3. SYSTEM 103- INTERIOR EXPOSED

   a. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils
   b. Primer: Hi-Build Epoxoline II Series L69 at 3.0 – 5.0 mils dft
   c. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

4. SYSTEM 104 - IMMERSION – TYPICAL MUNICIPAL WASTEWATER

   a. Surface Preparation: SSPC-SP10 Near White Blast Cleaning with a minimum angular anchor profile of 1.5 mils
   b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   c. Intermediate: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   d. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

5. SYSTEM 105 - IMMERSION – POTABLE WATER REQUIRING NSF 61 CERTIFICATION
   a. N/A

6. SYSTEM 106 - IMMERSION – MODERATE TO SEVERE CHEMICAL EXPOSURE INCLUDING H_2S VAPOR EXPOSURE – SMALL STRUCTURES - MECHANISMS

   a. Surface Preparation: SSPC-SP10 Near-White Blast Cleaning with a minimum angular anchor profile of 2.0 mils
   b. Primer: Tneme-Liner Series 61 at 10.0 – 12.0 mils dft
   c. Finish: Tneme-Liner Series 61 at 10.0 – 12.0 mils dft

7. SEVERE WASTEWATER H_2S VAPOR EXPOSURE – LARGE STRUCTURES

   a. N/A

8. SYSTEM 107 - BELOW GRADE

a. Steel Surface Preparation: SSPC-SP10 Near White Blast Cleaning
b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
c. Intermediate: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
d. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

9. SYSTEM 108 – MARGINALLY PREPARED SURFACES (MAINTENANCE) (NON-IMMERSION) INTERIOR/EXTERIOR

a. Surface Preparation: SSPC-SP2/SP3 Hand and Power Tool Cleaning, feather all rough edges, remove loose rust, dirt, and other surface contaminants with sandpaper, scotch brite, etc.
b. Primer: Chem-Build Series 135 3.0 to 5.0 mils dft
c. Interior Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
d. Exterior Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

B. FACTORY PRIMED STEEL – DOORS, FRAMES & EQUIPMENT

1. SYSTEM 121 - CHEMICAL EXPOSURE

a. Surface Preparation: SSPC-SP2/SP3 Hand and Power Tool Cleaning, feather all rough edges, remove loose rust, dirt, and other surface contaminants with sandpaper, scotch brite, etc.
b. Primer: Chem-Build Series 135 3.0 to 5.0 mils dft
c. Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

2. SYSTEM 122 - NON-CHEMICAL EXPOSURE

a. Surface Preparation: Clean & Dry
b. Primer: Enduratone Series 1028 at 2.0 – 3.0 mils dft
c. Finish: Enduratone Series 1028 at 2.0 – 3.0 mils dft

C. GALVANIZED STEEL, STAINLESS STEELS, & NON- FERROUS METALS

1. SYSTEM 201 – INTERIOR/EXTERIOR EXPOSED PIPE & MISC. FABRICATIONS

a. Surface Preparation: SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals to achieve a uniform anchor profile of 1.0 – 2.0 mils
b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
c. Interior Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
d. Exterior Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

2. SYSTEM 202 –IMMERSION PIPE & MISC. FABRICATIONS

a. Surface Preparation: SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals to achieve a uniform anchor profile of 1.0 – 2.0 mils
b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
c. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

3. SYSTEM 203 –DISSIMILAR METAL INSULATION – ALUMINUM IN CONTACT WITH CONCRETE, STAINLESS IN CONTACT WITH CARBON STEEL.

   a. Surface Preparation: SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals to achieve a uniform anchor profile of 2.0 – 3.0 mils
   b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   c. Intermediate: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   d. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

4. SYSTEM 204 – INTERIOR DRY EXPOSED – OVERHEAD DECKING AND DUCT WORK

   a. Surface Preparation: Clean and Dry
   b. Prime: Uni-Bond DF Series V115 at 2.0 – 4.0 dft mils
   c. Finish: Uni-Bond DF Series V115 at 2.0 – 4.0 dft mils

D. DUCTILE OR CAST IRON – PIPE, PUMPS & VALVES

1. SYSTEM 211 - BELOW GRADE

   a. Ductile Iron Surface Preparation: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.
   b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   c. Intermediate: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   d. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

2. SYSTEM 212 –EXTERIOR EXPOSED (OUTSIDE DIAMETER)

   a. Surface Preparation of Ductile Iron: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.
   b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   c. Intermediate: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   d. Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

3. SYSTEM 213 – INTERIOR EXPOSED AND/OR IMMERSION (OUTSIDE DIAMETER)

   a. Surface Preparation of Ductile Iron: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.
   b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
   c. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

4. INTERIOR EXPOSED AND/OR IMMERSION, H_2S VAPOR EXPOSURE (INSIDE DIAMETER)

   a. N/A

E. PVC

1. SYSTEM 221 - EXTERIOR EXPOSED

a. Surface Preparation: Scarify, Clean and Dry
b. Primer: Hi-Build Epoxoline II Series L69 at 2.0 – 4.0 mils dft
c. Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

2. SYSTEM 222- INTERIOR EXPOSED

a. Surface Preparation: Scarify, Clean and Dry
b. Primer: Hi-Build Epoxoline II Series L69 at 2.0 – 4.0 mils dft
c. Finish: Hi-Build Epoxoline II Series L69 at 2.0 – 4.0 mils dft

F. CONCRETE & MASONRY –PRECAST, POURED-IN-PLACE, CAST-IN-PLACE AND CMU

1. SYSTEM 301 – INTERIOR WALLS NON-CHEMICAL EXPOSED

a. Surface Preparation: SSPC-SP13/NACE 6 – Clean & Dry
b. Filler for Porous Surfaces: Epoxoblock WB Series 1254 at 75 – 150 sq. ft./gal
c. Primer: Enduratone Series 1028 at 2.0 – 3.0 mils dft
d. Finish Enduratone Series 1028 at 2.0 – 3.0 mils dft

2. SYSTEM 302 - INTERIOR WALLS CHEMICAL EXPOSED

a. Surface Preparation: SSPC-SP13/NACE 6 – Clean & Dry
b. Filler (if needed): Epoxoblock WB Series 1254 at 75 – 150 sq. ft./gal
c. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
d. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

3. ULTRAFILTRATION TANKS – MEMBRANE BASINS – NSF61 POTABLE WATER

a. N/A

4. SYSTEM 306 – BELOW GRADE OR IMMERSION

a. Surface Preparation: SSPC-SP13/NACE 6, ICRI CSP 3
b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
c. Intermediate: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
d. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

5. SYSTEM 307 – IMMERSION - MODERATE CHEMICAL AND H_2S EXPOSURE

a. Surface Preparation: SSPC-SP13/NACE 6, ICRI CSP 2-3
b. Surfacer/Filler: Surfacing Epoxy Series 215 as needed for surfacing, patching, filling voids and bugholes as per product data sheet.
c. Primer: Tneme-Liner Series 61 at 10.0 – 12.0 mils dft
d. Finish: Tneme-Liner Series 61 at 10.0 – 12.0 mils dft

6. SYSTEM 308 - WASTEWATER H_2S VAPOR EXPOSURE

a. Surface Preparation: Abrasive Blast to remove laitance, form release agents, curing compounds, sealers, and other contaminants and to provide surface profile in accordance with SSPC-SP13/NACE6, ICRI CSP5.

b. Filler: MortarClad Series 218 - parge coat of entire surface at a minimum thickness of 1/16” inch.
c. Finish: Perma-Glaze Series 435 at 30 - 40 mils DFT applied in multiple coats

G. CONCRETE FLOORS

1. SYSTEM 311– LIGHT TRAFFIC, MILD CHEMICAL EXPOSURE

a. Surface Preparation: SSPC-SP13/NACE 6, Minimum ICRI CSP-2
b. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
c. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

2. SYSTEM 312– MODERATE TO SEVERE ABUSE, CHEMICAL EXPOSURE
a. Surface Preparation: SSPC-SP13/NACE 6, Minimum ICRI CSP-3
b. Primer: Epoxoprime Series 201 at 6.0 – 8.0 mils dft
c. Intermediate: Tneme-Glaze Series 282 at 6.0 – 8.0 mil dft
d. Finish: Tneme-Glaze Series 282 at 6.0 – 8.0 mil dft

3. SYSTEM 313– DRY AREAS – WAREHOUSE STORAGE

a. Surface Preparation: Clean and Dry – as per product data sheet
b. Finish: CT Densifyer Series 629 at 300 – 350 square feet per gallon

4. RESINOUS FLOORING

a. N/A

H. CONCRETE – SECONDARY CONTAINMENT

1. N/A

I. WALLS

1. SYSTEM 401 - GYPSUM WALL BOARD - INTERIOR

a. Prime: Uni-Bond DF Series V115 at 2.0 – 4.0 mils dft
b. Intermediate: Enduratone Series 1028 at 2.0 – 3.0 mils dft
c. Finish: Enduratone Series 1028 at 2.0 – 3.0 mils dft

2. SYSTEM 402 - WALL BOARD – WATER RESISTANT – INTERIOR WALLS CHEMICAL EXPOSURE

a. Surface Preparation: Clean & Dry
b. Surfacer/Filler for joints and screw holes: Surfacing Epoxy Series 215 and Series 273 Part D fiberglass tape
c. Primer: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft
d. Finish: Hi-Build Epoxoline II Series L69 at 4.0 – 6.0 mils dft

J. WOOD

1. SYSTEM 411 - INTERIOR

a. Surface Preparation: Sand rough areas. Clean and dry.
b. Prime: Uni-Bond DF Series V115 at 2.0 – 4.0 mils dft
c. Intermediate: Enduratone Series 1028 at 2.0 – 3.0 mils dft
d. Finish: Enduratone Series 1028 at 2.0 – 3.0 mils dft

K. MISCELLAENOUS

1. SYSTEM – 601- EXPOSED SAWCUT CONCRETE FACE AND EXPOSED REINFORCEMENT

a. Surface Preparation: According to manufacturer's recommendations.
b. Coating: Sika Armatec 110 EpoCem, or equal (Coverage per manufacturer's recommendations. Minimum 20 mil. thickness).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

C. Remove by blast cleaning to SSPC-SP 10 Near White Blast Cleaning any bitumastic coating or improper primer on any material or equipment which is to be painted and arrives at the construction site with a bitumastic coating or a priming system not specified in paragraph 2.4 Coating Systems.

3.2 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

C. Remove mask, or otherwise protect hardware, lighting fixtures, switchplates, machines, surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting. Mask openings in motors and equipment to prevent abrasives, paint and other materials from entering.

D. Exercise care not to damage adjacent work during sandblasting operations. Conduct spray painting under controlled conditions. Promptly repair any damage to adjacent work or adjoining property occurring from sandblasting or spray-painting operations.

3.3 SURFACE PREPARATION

A. Surfaces shall be prepared in accordance with manufacturer's written instructions as outlined in the product data sheet and application guides.

1. Surface preparation shall be as specified in the designated coating system.

B. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

C. Steel – Structural, Tanks, Pipe and Equipment:

1. Grind smooth to a rounded contour sharp edges and welds, and remove weld splatter.
2. Prior to the specified surface preparation SSPC-SP1 Solvent Cleaning shall be performed to all surfaces.
3. SSPC-SP2 Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.
4. SSPC-SP3 Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.
5. SSPC-SP5/NACE 1 White Metal Blast Cleaning: Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.
6. SSPC-SP6/NACE 3 Commercial Blast Cleaning: Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each 9-square inch of surface area.
7. SSPC-SP10/NACE 2 Near-White Blast Cleaning: Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each 9-square inch of surface area.
8. Apply prime coat before rust bloom forms or within 24-hours, whichever is earlier.
9. Do not allow blast cleaned or bare surfaces to stand overnight before coating.

D. Ductile or Cast Iron – Pipe, Pumps, Valves and Fittings

1. Ductile iron pipe and fittings shall be delivered without asphalt, cement lining, or any other lining.
2. All oils, small deposits of asphalt paint, grease, and soluble deposits shall be removed in accordance with NAPF 500-03-01 Solvent Cleaning prior to abrasive blasting.
3. Exterior Preparation: Uniformly abrasive blast the entire exterior surface using angular abrasive to an NAPF 500-03-04: "External Pipe Surface Condition". When viewed without magnification, the exterior surfaces shall be free of all visible dirt, dust, loose annealing oxide, loose mold coating, rust and other foreign matter. Tightly adherent annealing oxide, mold coating and rust staining may remain on the surface provided they cannot be removed by lifting with a dull putty knife. Any area where rust reappears before application shall be re-blasted. The surface shall contain a minimum angular anchor profile of 1.5 mils in accordance with ASTM D 4417, Method C.

E. Galvanized Steel, Aluminum, Stainless Steel, and Non-Ferrous Metal Substrates:

1. SSPC-SP16 Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals: Not for carbon steel. Requires sweep blasting of the entire surface to remove all foreign matter. Dense and uniform surface profile is required.
2. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions.

F. Wood Substrates:

1. Wood surfaces to be painted shall be cleaned of dirt, oil or other foreign substances with mineral spirits, scrapers, sandpaper or wire brush. Seal knots and pitch pockets with shellac reduced with equal parts of shellac thinner (denatured alcohol) before sandpaper finishing with fine grit and remove sanding dust. After the prime coat is dry, fill cracks and holes with putty or spackling compound. When filler is hard, sand flush with the surface using fine grit sandpaper. Sand lightly between coats with fine grit, open-coated sandpaper.

G. PVC Substrates:

1. PVC surfaces to be painted shall be clean, dry and free of oil, grease, and other contaminants and lightly sanded to create a surface for coating to adhere to.

H. Concrete and Masonry Substrates:

1. All surfaces must be clean, dry and free of oil, grease and other contaminants, prior to preparation in accordance with NACE No. 6/SSPC-SP13. Concrete surfaces must be sound and capable of supporting the coating system.
2. Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Shot-blast or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers, existing coatings, and other contaminants and to provide the recommended ICRI-CSP Profile.
3. Cracks, voids and other surface imperfections should be filled with the recommended filler or surfacer prior to the installation of the materials.
4. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through the coating system according to manufacturer's written recommendations.
5. Level or grind concrete substrates to produce a uniform and smooth surface, including removal of sharp edges, ridges, form fins, and other concrete protrusions.
6. All surfaces to be painted or repainted, shall be repaired, cleaned and finished to the standards as specified herein and in Division 3 for new concrete.

I. Gypsum Drywall:

1. Sand joint compound with fine grit, open-coated sandpaper to provide a smooth flat surface. Avoid heavy sanding of the adjacent wall board surfaces, which will raise the nap of the paper covering. Remove dust from the surface by wiping with clean rags or other means. If additional joint finishing is required to provide a smooth surface, the same joint compound of a ready-mixed spackling compound should be used. Putty, patching pencils, caulking or masking tape should not be applied to dry wall surfaces to be painted. Finish level 4 or 5 must be achieved prior to beginning to paint. Level shall be suitable for coating system to be applied.
2. Lightly scuff-sand tape joints after priming to remove raised paper nap. Take care not to sand through the prime coat and remove dust by wiping with clean rags.

3.4 APPLICATION

A. Apply coatings in accordance with manufacturer's written instructions as outlined in the product data sheet, application guides and technical bulletins.

B. The application of coatings to steel substrates shall be in accordance with SSPC PA1 - Shop, Field, and Maintenance Painting of Steel.

C. All painting shall be done by skilled and experienced craftsmen and shall be of highest quality workmanship. Coating systems shall be as specified herein.

D. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.

E. Uniformly apply coatings at spreading rate required to achieve specified Dry Film Thickness (DFT).

F. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems

G. Paint back sides of access panels and removable or hinged covers to match the exposed surfaces.

H. Equipment manufacturer or supplier shall provide touch-up paint for items with shop applied finish coats.

I. Where specified in the individual sections, primer coat(s) shall be applied in the shop by the equipment manufacturer. The shop coats shall be as specified and shall be compatible with the field coat or coats.

J. Certification: The Contractor shall obtain from the equipment manufacturer or supplier, prior to shipment of equipment, a written certification that surface preparation, coating brand, material, DFT and application method complied with this section.

K. If the shop applied coating is in good condition, as determined by the Engineer, the field application may consist of touching up the shop primer coat to achieve the specified film thickness in accordance with the product data sheet.

    1. The Owner/Engineer reserves the option, however, to require that badly damaged and poorly applied shop coatings be removed and the surfaces recoated in accordance with the specified system requirements.

L. Shop applied coatings of unknown composition shall be completely removed before the indicated coatings are applied.

    1. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. If present, this coating shall be removed.

M. Shop primed equipment shall be prepared as per manufacturer's recommendations in the field before finish coats are applied.

N. Shop Applied Bituminous Paint or Asphalt Varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.

O. In accordance with SSPC-PA11 Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating shall be applied to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present.

P. Each coat of paint shall be of a slightly different shade, to facilitate inspection of surface coverage of each coat.

Q. Sprayed Finishes: Spray paint finish doors, frames and windows, where required. Brush or roller finishes will not be acceptable.

R. Install piping markers and safety signs only after painting and finish work is completed.

3.5 FIELD QUALITY CONTROL, INSPECTION AND TESTING

A. The Applicator shall perform the quality control procedures listed below in conjunction with the requirements of this section.

B. Inspect materials upon receipt to ensure that products are supplied by the approved Manufacturer.

C. Surface Profile and Degree of Surface Cleanliness: Inspect and record substrate profile (anchor pattern) and degree of cleanliness. Surfaces shall meet the manufacturer’s recommended anchor profile and degree of blast cleaning.

1. Visually confirm the specified degree of surface cleanliness of the ferrous metal surface in accordance with SSPC-VIS 1.
2. The specified surface profile of the prepared substrate shall be verified in accordance with ASTM D4417 – Method C Replica Tape or NACE RP0287.

D. Concrete Surface Profile: Inspect and record substrate profile. Surface profile shall be equal to the manufacturer’s recommendation in accordance with ICRI Guideline 310.2 and SSPC-SP13/NACE No. 6.

1. Compare the substrate profile once every 50 square feet with the Concrete Surface Profile (CSP) comparators in accordance with ICRI Guideline No. 310.2.

E. Concrete Moisture Testing: After surface preparation verify concrete dryness in accordance with one or more of the following moisture tests.

1. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

   a. Moisture vapor transmission not to exceed three pounds per 1,000 square feet in a 24-hour period.

2. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

   a. Relative humidity not to exceed 80 percent.

3. ASTM D4263— Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

a. No moisture present

4. Consult manufacturer regarding questions and or recommendations in reference to moisture problems or questions.

F. Surface Cleanliness: Prepared surfaces shall be inspected for surface cleanliness after cleaning and drying, prior to the coating application.

G. Measure and record ambient air temperature, relative humidity and dew point temperature once every two hours of each work shift to ensure that the products are being applied within the manufacturer's recommendations.

H. Measure and record substrate temperature once every two hours using an infrared or other surface thermometer to ensure that the products are being applied within the manufacturer's recommendations.

I. Film Thickness:

1. Wet-Film Thickness shall be taken in accordance with ASTM D4414 or other agreed-upon method.
2. The Dry-Film Thickness (DFT) shall be measured in accordance with SSPC-PA2 Measurement of Dry Coating Thickness. Verify DFT of each coat and total DFT of each coating system are as specified.

J. Holiday (Spark) Testing: Upon full cure of coating system numbers 104, 105, and 106 the coating system shall be checked by spark detection in accordance with NACE SP0188 and the Manufacturer's instructions to verify a pinhole-free surface. Areas which do not pass the spark detection test shall be corrected at no cost to the Owner.

1. Submit written reports of the test results and actions taken to correct non-conforming work.

K. The Applicator is responsible for keeping the Engineer informed of progress so that Engineer may provide additional quality control at his discretion.

L. Inspection by the Engineer or others does not absolve the applicator from his responsibilities for quality control inspection and testing as specified herein or as required by the Manufacturer's instructions.

3.6 MANUFACTURER'S FIELD SERVICES

A. Manufacturer's technical representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.7 ACCEPTANCE CRITERIA

A. Surfaces shall be prepared, applied, and tested in accordance with the specification and referenced standards herein.

3.8 REPAIR

A. Damaged Materials: Repair or replace damaged materials and surfaces not scheduled to be coated.

B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.9 PROTECTION AND CLEANING

A. Protect the completed Work from traffic, physical abuse, immersion and chemical exposure until the complete system has thoroughly cured as per manufacturer's written instructions.

B. At the completion of the Work, Applicator shall remove materials and debris associated with the Work of this Section.

C. Clean surfaces not designated to receive coating. Restore designated areas in a manner acceptable to Engineer.

D. Protect the completed Work from damage until Final Acceptance. Coating damaged in any manner shall be repaired or replaced at the discretion of Engineer, at no additional cost to Owner.

3.10 COATING/FINISH SCHEDULE

A. As shown in Drawings.

END OF SECTION 098000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 110513 – COMMON MOTOR REQUIREMENTS FOR EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes AC induction electric motors to be provided with associated driven equipment. Motor voltage, speed and enclosures are specified in the equipment specifications and/or the Contract Drawings. Unless otherwise specified, motors shall be provided by the manufacturer of the driven equipment under the provisions of the individual equipment specification.

1.2 MOTOR RATING

A. Motor horsepower ratings as shown on the drawings and noted on the specifications are estimates only and it is the responsibility of the CONTRACTOR and/or VENDOR to furnish motors, electric circuits, power feeds and other equipment whose ratings meet the requirements for the submitted horsepower and amperage.

B. This section applies to electric motors rated 480 V and below.

1.3 CODE AND STANDARDS

A. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 220, 250, and 430, as applicable to installation, and construction of motor controllers.

B. AFBMA Compliance: Comply with applicable requirements of AFBMA 9 & 11, "Load Rating and Fatigue Life for Ball and Roller Bearings."

C. UL Compliance: Comply with applicable requirements of UL 674, “Electric Motors and Generators, for Use in Division 1 Hazardous (Classified) Locations” and UL 1004, “Electric Motors”.

D. IEEE Compliance: Comply with recommended practices contained in IEEE Standard 112, "Standard Test Procedures for Polyphase Induction Motors and Generators," and IEEE Standard 841, “Standard for Petroleum and Chemical Industry – Totally Enclosed Fan Cooled (TEFC) Squirrel Cage Induction Motors – Up to and Including 500 HP”.

E. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies", NEMA Standard ICS 6, “Enclosures for Industrial Controls and Systems, ”Pub No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)" and NEMA MG 1, “Motors and Generators”.

1.4 MAINTENANCE DATA

A. Submit maintenance data and parts list for each motor and auxiliary component; including troubleshooting maintenance guide. Also, provide product data and shop drawings in a maintenance manual, in accordance with requirements of the Contract Documents.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions for each motor in accordance with the individual equipment specification. As a minimum, the following information shall be provided:

1. Manufacturer name, type and model number
2. Motor outline, dimensions and weight
3. Manufacturer’s general descriptive information relative to motor features
4. Type of bearing and method of lubrication
5. Rated size of motor and service factor
6. Temperature rise and insulation rating
7. Full-load rotative speed
8. Efficiency at full, ¾ and ½ load
9. Full load current
10. Locked-rotor current
11. Space heater wattage and voltage, if applicable
12. If a winding overtemperature device is required, provide a response curve for the temperature device, wiring diagram and specifications
13. If a moisture detection system is required, provide a typical wiring diagram and a moisture detection relay to be installed by the CONTRACTOR or VENDOR in the associated motor controller.

B. Shop Drawings: Submit shop drawings of electric motors showing accurately scaled equipment locations and spatial relationships to associated drive equipment.

C. Wiring Diagrams: Submit power and control wiring diagrams for electric motors showing connections to electrical power panels, feeders, and equipment.

D. Operations and Maintenance Data: Submit operation and maintenance information.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide electric motors and ancillary components that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation.

2.2 SERVICE CONDITIONS

A. Unless specified otherwise, motors shall be suitable for continuous operation at an elevation of 0 to 3000 feet above mean sea level.

B. Unless specified otherwise, motors located outdoors shall be suitable for continuous operation from -25 to 55°C; motors located indoors shall be suitable for continuous operation from 0 to 50°C.

C. All motors shall be able to operate under power supply variations in accordance with NEMA MG 1 – 14.30.

2.3 NAMEPLATES

A. Motor nameplates shall be engraved or stamped stainless steel. Information shall include those items as enumerated in NEMA Standard MG 1, as applicable. Nameplates shall be permanently fastened to the motor frame and shall be visibly positioned for inspection.

2.4 CONSTRUCTION

A. All motors provided under this specification shall have the following features of construction:

1. Frames shall be steel for motors smaller than ½ horsepower and cast iron for motors ½ horsepower and larger.
2. Cast metal shrouds and covers for non-sparking fan blades.
3. Non-hygroscopic motor leads.
4. NEMA Design-B as standard design. Other designs if required must be submitted and approved in writing by the ENGINEER.
5. Motor Service Factor of 1.15 for Sine-Wave and 1.0 for Inverter Duty.
6. Grounding terminal
7. Windings shall be copper
8. Rotor cages shall be die cast aluminum or fabricated copper
9. Shafts shall be made from carbon steel.

2.5 MOTORS LESS THAN ½ HORSEPOWER

A. General:

1. Unless specified otherwise, motors less than ½ horsepower shall be squirrel cage, single phase, capacitor start, induction run type.
2. Single phase motors shall have class B insulation as a minimum.
3. Motors for fans less than 1/8 horsepower may be split-phase or shaded pole type.
4. Winding shall be copper.

B. Rating:

1. Unless specified otherwise, motors less than ½ horsepower shall be rated for operation at 115 volts, single phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1 – 10.35.

2. Dual voltage (115/230) rated motors are acceptable if all leads are brought out to the conduit box.
3. Motors shall be non-overloading at all points of the equipment operation.

2.6 MOTORS ½ HORSEPOWER AND LARGER

A. General:

1. Unless specified otherwise, motors ½ horsepower and larger shall be 3 phase, squirrel cage, full voltage start induction type.
2. Unless otherwise specified, motors shall have a NEMA MG 1-1.16 design letter B or C torque characteristic as required by the driven equipment's starting torque requirement.
3. Winding shall be copper.
4. Motors shall be equipped with a set of thermal overload switches with dry contacts available at the motor terminal box:

B. Rating:

1. Unless specified otherwise, motors ½ horsepower and larger shall be rated for operation at 460 volts, 3 phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1 – 10.35.
2. Dual voltage (230/460) rated motors are acceptable if all leads are brought out to the conduit box.
3. Motors for variable frequency systems shall not be required to deliver more than 80% of the motor's service factor rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

C. Enclosures and Insulation:

1. Motors shall be classified as Type 1 (Process) or Type 2 (Explosion proof) based upon the location of the motor and the associated area classification.
2. Temperature rise for all motors shall not exceed that permitted by Note II, Paragraph 12.42 of NEMA MG 1.
3. Motor Insulation shall be non-hygroscopic.
4. Type 1 motors (Process):

   a. Type 1 motors shall be premium energy-efficient motors, totally enclosed, fan cooled (TEFC)
   b. All motors shall have Class H insulation with Class B temperature rise.
   c. All internal surfaces shall be coated with an epoxy paint.
   d. Motors shall be rated for corrosive atmosphere duty.

5. Type 2 Motors (Explosion Proof):

   a. Explosion proof motors shall be UL listed in accordance with UL 674 for Class I, Group D hazardous atmospheres.
   b. The motor shall have Class H insulation.

c. A UL-approved Type 316 stainless steel breather/drain device shall be provided in the motor drain hole.

d. The motor shall be provided with a frame temperature thermostat which meets the UL frame temperature limit code T2A (280°C). The thermostat shall contain an automatically reset, normally closed contact rated 2 amperes at 230 VAC.

2.7 MOTORS FOR VARIABLE FREQUENCY DRIVES

A. Motors intended for use with variable frequency drives shall be compatible with the characteristics of the intended variable frequency inverter.

B. Motors shall be Type 1 or Type 2 as specified in 2.06C.

C. Motors shall withstand a pulse voltage of at least 1750 volts with a rate of rise up to 750V per microsecond.

D. Motors shall be certified by the manufacturer as suitable for inverter duty and shall have as a minimum a 10:1 turndown ratio (6-60Hz).

E. Motors shall be capable of running above the rated RPM up to 70 Hz (116.67% of rated RPM) so long as the load current does not exceed the full load amps of the motor.

F. As motors that are VFD driven typically have a service factor of 1.0, motors shall be oversized such that the motor does not exceed 80% of full load amps under normal operating conditions.

2.8 MOTOR EFFICIENCIES

A. Type 1 and Type 2 motors in accordance with NEMA MG 1 Table 12-11 and 12-12 and Type 2 in accordance with IEEE 841 Table 2 motor minimum nameplate efficiency for 900, 1200 and 1800 rpm motors, when operating on a sinusoidal power source shall conform to the following (in accordance with IEEE 112B testing procedures):

Motor Horsepower	Guaranteed Minimum Efficiency (%)		
	900 RPM	1200 RPM	1800 RPM
1	70.0%	78.5%	81.5%
1.5	72.0%	81.5%	82.5%
2	80.0%	81.5%	82.5%
3	81.5%	86.5%	84.0%
5	82.5%	86.5%	84.0%
7.5	82.5%	88.5%	88.5%
10	86.5%	88.5%	88.5%
15	86.5%	89.5%	89.5%
20	87.5%	90.2%	91.7%
25	87.5%	91.0%	91.7%
30	89.5%	91.0%	91.7%

40	89.5%	92.4%	92.4%
50	90.2%	92.4%	92.4%
60	90.2%	93.0%	93.0%
75	91.7%	93.0%	93.6%
100	91.7%	93.6%	94.1%
125	92.4%	93.6%	94.1%
150	92.4%	94.5%	94.5%
200	92.4%	94.5%	94.5%
250	93.6%	94.1%	94.1%

2.9 CONDUIT BOXES

A. Conduit boxes shall be sized based on the conduit number and conduit size indicated on the drawings. Provide over-sized boxes with the number of openings as required to accommodate the conduits required.

B. Conduit boxes shall be split construction with threaded hubs and shall conform to IEEE 841 for Type 1 and Type 2 motors. Motors shall be furnished with petroleum-resistant gaskets at the base of the conduit box and between the halves of the conduit box.

C. Conduit boxes shall be designed to rotate in order to permit installation in any of four positions 90 degrees apart.

2.10 BEARINGS

A. Bearings may be oil or grease lubricated ball or angle contact roller bearing rated for a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or 100 at the ambient temperature specified. Motor designs employing cartridge type bearings will not be accepted. Bearings shall be fitted with lubricant fill and drain or relief fittings. Belt loads shall not exceed forces calculated from NEMA MG 1 Table 14-1.

2.11 LIFTING EYES

A. Motors weighing more than 50 pounds shall be fitted with at least one lifting eye and motors weighing over 150 pounds shall be fitted with two lifting eyes.

2.12 SPACE HEATERS

A. Motors that are located outdoors shall be equipped with Space Heaters to prevent condensation inside the motor enclosure after motor shutdown and maintain the temperature of the windings at not less than 5°C above outside ambient temperature.

B. Heaters shall be flexible wraparound type rated 120 volts, single phase, 60 Hz unless otherwise noted. The space heater rating in watts and volts shall be noted on the motor nameplate or on a second nameplate. Space heater leads H1 and H2 shall be brought to a separate terminal block or pigtails in the motor conduit box or separate conduit box with a threaded conduit opening.

PART 3 - EXECUTION

A. Install electric in accordance with equipment manufacturer's written instructions, and with recognized industry practices. Comply with applicable requirements of NEC, UL, and NEMA standards, to ensure that products fulfill requirements.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

C. Ensure that the motor is properly grounded from the incoming motor leads and that the frame is bonded to the grounding electrode system.

D. Verify breather/drain fittings have been installed as specified.

E. Prior to energizing, check circuitry for electrical continuity, and for short-circuits. Winding insulation resistance for motors shall not be less than 10-megohms measured with a 1000-VAC megohmeter at 1-minute at or corrected to 40°C.

F. Check rotation of each motor for proper direction.

G. Upon completion of installation of motor controller equipment and electrical circuitry, energize controller circuitry and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION 110513

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, Grade A, with plain ends and welded steel collar; zinc coated. Hot dip galvanize after fabrication.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends. Hot dip galvanize after fabrication.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Connecting Bolts and Nuts: 316 Stainless Steel of length required to secure pressure plates to sealing elements.

B. Acceptable Manufacturers:

1. Link Seal
2. Or equal.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves 1 inch longer than penetration through floors.

2. Use foam and polyurethane caulk to seal space between pipe and sleeve.

D. Install sleeves for pipes passing through interior partitions.

1. Size sleeve for pipe and link seal.
2. Cut sleeves to length for mounting flush with both surfaces.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
4. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION 220517

SECTION 220553 – IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-22 General Mechanical Materials and Methods section and is part of each Division-22 section making reference to identification devices specified herein.

1.2 DESCRIPTION OF WORK

A. Furnish mark and install identification devices for all exposed piping installed in this work.

B. Furnish and securely attach an engraved plastic nameplate to all new pieces of equipment (Owner or Contractor furnished).

C. Tag all valves installed in this work.

1.3 QUALITY ASSURANCE

A. Codes and Standards:

B. ANSI Standards:

C. Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 IDENTIFICATION OF PIPING

A. Identification of all exposed pipe shall be accomplished by color-coding with bands and by lettering. Color bands shall be pressure-sensitive adhesive-backed vinyl cloth or plastic tape.

B. Each pipe identification shall consist of 2 color-coded bands, a printed label identifying the name of the pipe, and a flow arrow to indicate direction of flow in the pipe. All labels shall be preprinted on pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Arrows shall be die-cut of the same type of material as the labels.

C. Preprinted identification devices shall be as manufactured by W.H. Brady Co., Seton Nameplate Corp., or equal.

2.2 VALVE TAGS

A. Valve Tags: Provide 1-1/2" x 3" size stainless steel or plastic valve tags with stamp-engraved 1/8" high letters.

B. Valve Tag Fasteners: Provide manufacturer's standard solid stainless steel chain (wire link or beaded type), or solid S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.3 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting.

3.2 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers on each piping system, and include arrows to show normal direction of flow:

Example of System Identification:

FLUID ABBREVIATION	FUNCTION IDENTIFICATION	ID COLOR
SD	SANITARY DRAINS & VENTS	BLUE
NPW	NON-POTABLE WATER	PURPLE

Coordinate with the Owner for all piping systems identification ID Coloring.

B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, crawl spaces, plenums) and exterior non-concealed locations.

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ ceilings or enter non-accessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.

3.3 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures. List each tagged valve in valve schedule for each piping system. Valve tags shall include the following minimum information:

1. Plan Identification
2. Normal Position
3. Duty
4. Area served
5. Valve type.

B. Example of typical valve tag (where it is apparent what valve is serving):

B-14 Automatic 3-way mixing chlorine feed pump rate control
Position: 1/2 open
Function: Control flow rate

3.4 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as non-potable water outlets. For non-potable water outlets use red engraved laminate with white lettering.
2. Pumps, compressors.
3. Press.
4. Air Handlers and Exhaust Fans, Furnaces, Condensing Units.
5. Polymer Feed Units.
6. Tanks and pressure vessels.
7. Open Control Equipment.

B. Lettering Size:

Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

C. Text of Signs:

In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

D. A sample identification tag for equipment could be as follows:

Heating water pump Symbol P-1

Rating: 900 gpm, 120 ft. hd.
Maintenance: Lubricate with type C lubricant.

3.5 PANEL IDENTIFICATION

A. All panel devices on panel faces shall have engraved black face formica with white engraved lettering labels.

B. All internal panel components shall have engraved black face formica with white engraved lettering labels. Fasten label beneath each device.

C. All panel wiring and tubing shall be numerically or alphabetically coded.

3.6 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division.

B. Cleaning: Clean face of identification devices.

END OF SECTION 220553

SECTION 260000 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. General requirements which apply to all electrical aspects of the work.

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents in order to provide a complete and coordinated project.

1.2 REFERENCES

A. The installation and commissioning of the Electrical System shall conform to all applicable codes, regulations, standards and specifications, including, but not limited to those listed below. These publications are referenced to by designation but not by edition. The latest edition accepted by the Authority Having Jurisdiction in effect at the time of bid shall govern.

1. State and Local Codes and Authority Having Jurisdiction (AHJ)
2. National Electric Code (NEC).
3. National Fire Protection Association (NFPA)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. American National Standards Institute (ANSI)
6. American Society for Testing and Materials (ASTM)
7. Insulated Cable Engineers Association (ICEA)
8. National Electrical Manufacturers Association (NEMA)
9. Federal Occupational Safety and Health Act (OSHA)
10. Underwriters Laboratories, Inc. (UL)
11. International Society of Automation (ISA)

1.3 DEFINITIONS

A. Refer to the Contract Drawings sheet E001 for a list of abbreviations associated with the Electrical System. In addition, the following definitions are used in this section:

1. AHJ – Authority Having Jurisdiction
2. I&C – Instrumentation and Controls
3. IS – Instrumentation Supplier
4. NEC – National Electric Code
5. VFD – Variable Frequency Drive
6. UL - Underwriters Laboratories, Inc.

1.4 ELECTRICAL SYSTEMS REQUIREMENTS

A. The Work is to provide all labor and materials necessary for erecting a complete and operational Electrical System, tested and ready for continuous use as described by the Contract Documents. The Electrical System shall be constructed in accordance with the Contract Documents, and Federal, State, and Local codes and regulations. In addition, the Work shall adhere to the following general provisions:

1. The Electrical Contractor shall obtain all necessary permits required by the AHJ. In addition, the Electrical Contractor shall ensure that all inspections required by the AHJ are coordinated, conducted and documented.

2. All work shall be completed in a neat, workmanlike manner in accordance with the latest NEC standards of installation under competent supervision.

3. The Electrical Contractor shall visit the job site prior to bidding to become familiar with existing conditions and other factors, which may affect the execution of the work. Include all related costs in the initial bid proposal.

4. Coordinate work with the utilities providing services on this project. This may include but is not limited to the electric utility, telephone utility, cable TV/Internet utility. All electrical work associated with utilities shall be provided and installed per the utility requirements.

5. All materials shall be new and of the best quality, manufactured in accordance with the requirements listed in part 1.2 of this section. The Contractor shall furnish and install the parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

6. Protect all electrical material and equipment that is being stored or has been installed against damage by other trades, weather conditions, or any other preventable causes. Equipment damaged during shipping, storage or construction, prior to acceptance by the engineer or the owner, will be rejected as defective.

7. Leave the site clean. Remove all debris, empty cartons, tools, conduit, wire scraps and all miscellaneous spare equipment and materials used in the work during construction. All components shall be free of dust, grit and foreign materials, left as new before final acceptance of work. Damaged paint and finishes shall be touched up or repainted with matching color paint and finish.

8. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 40 degrees C, and specifically rated for the altitude indicated on the Plans. Electrical equipment not rated for operation at that temperature shall be provided with air conditioning to meet the manufacturers' operating temperature.

9. If any contradictions, contrasts, non-homogeneity, or inconsistency appears, the strictest criteria noted and the collective requirements in any and all of the Contract Documents shall apply.

10. The Electrical Contractor shall perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of

conduits, whether inside, or outside of the buildings and structures. The Electrical Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.

B. Oversee and coordinate with all equipment and services being provided by the Contractor but outside of the Electrical Contractor's scope.

1. Inform all vendors and suppliers providing equipment related to the Electrical System the requirements of Division 26.

2. The Owner is not responsible for any additional costs incurred by requiring vendors and/or subcontractors to meet the requirements of Division 26.

3. If a vendor or supplier is unable to meet the requirements of Division 26, the Contractor may submit in writing to the Engineer the reasons for non-compliance. The Engineer will then evaluate the reasons and determine whether a solution may be determined or if a different vendor or supplier is required.

C. Prepare Electrical System Submittals as required by Division 26 and Section 013300. Coordinate with the IS and the requirements of Division 40 to ensure that all equipment being supplied by the Electrical Contractor and/or IS has been submitted.

D. Oversee the installation of the Electrical System.

E. Actively participate in loop testing as outlined in Division 40.

F. Actively participate in commissioning as outlined in Division 40.

G. Maintain record drawings.
   1. Maintain on the construction site a set of the Electrical Drawings that shall be continuously marked up during construction.
      a. The drawings should be updated at least weekly and will be checked monthly by the Owner's representative.
      b. Upon completion of startup, submit the marked-up drawings to the Engineer for review and for drafting.

H. Prepare O&M manuals.
   1. Provide O&M manuals in accordance with Section 017823.

I. Provide training on electrical equipment that has been installed.

1.5 ACTION SUBMITTALS

A. General
   1. Submittals for Division 26 shall meet the requirements of Section 013300 Contractor Submittals. In addition, the following requirements shall be met:
      a. Submittals shall include bills of materials with quantities, makes, models, exact part numbers and descriptions.

b. Edit all submittals such that only pertinent information is submitted. Neatly cross out information that does not apply, options that are not being supplied, etc.
c. Show product dimensions, construction and installation details, wiring diagrams, and specifications.
d. If there are exceptions to the Contract Drawings and Specifications, provide a list of exceptions with detailed explanations for the exceptions. The Engineer will review the list of exceptions and determine whether a solution may be determined or if the exception(s) will not be allowed.

2. Furnish submittals required by each Section within Division 26.
3. When submitting on equipment, use the equipment and instrumentation tags depicted in the Contract Drawings.

B. Recommended Spare Parts Submittal
1. Submit a list of spare parts for all of the equipment associated with the Electrical System. The list of spare parts shall include list pricing for each item.
2. Provide the name, address and phone number for each manufacturer and manufacturer's local sales representative.
3. Indicate whether or not the spare parts are being provided under this contract or not.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. All equipment supplied for this project shall meet the requirements of the NEC and shall be listed by and bearing the label of the UL.

B. The Electrical Contractor shall be a company that has been actively involved in the installation and commissioning of Electrical Systems for a minimum period of five years.

C. The Electrical Contractor shall have adequate facilities, manpower and technical expertise to perform the Work associated with the Electrical System and as outlined by the Contract Documents.

D. The Electrical Contractor shall have similar project experience of at least four successfully completed projects for a similar wastewater system. The Electrical Contractor company must have performed similar work for these projects as required herein.

PART 2 - PRODUCTS

2.1 MATERIALS AND METHODS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged or dirty materials, equipment, and parts are not considered to be new and unused and will not be accepted.

B. Field verification of scale dimensions on Plans is directed, since actual locations, distances, and levels will be governed by actual field conditions. The Contractor shall also review architectural, structural, yard, mechanical, and other Plans, and the accepted electrical and mechanical shop drawings, and shall adjust their work to conform to the conditions indicated therein.

C. The fabricator of major components, such as distribution panelboards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein. Where possible, the major components shall be manufactured and supplied by the same fabricator.

2.2 MANUFACTURERS

A. All equipment provided for the Electrical System shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. Refer to various Division sections for individual equipment manufacturers. Indicated manufacturers are subject to strict compliance with the specifications and complete project documents. The reference to a particular manufacturer does not relieve the Electrical Contractor from conforming to the specified requirements.

C. When providing like electrical components they shall be furnished by a single manufacturer and shall be consistent throughout the project. For example, a 20A 2-way light switch in one building should match a 20A 2-way light switch in another building in both make, model and features.

2.3 EQUIPMENT ASSEMBLIES

A. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.

B. Custom fabricated electrical control panels, and enclosures shall bear a serialized UL label affixed by a local inspector, and the serial number shall be submitted with the assembly record shop drawings.

2.4 OPERATING CONDITIONS

A. The Electrical System shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:

1. Environment: Wastewater Lift Station
2. Temperature Extremes: -4°F to 120°F (Outdoors); 40°F to 104°F (Indoors).
3. Relative Humidity: 20% to 90%, non-condensing.

B. Indoor and outdoor electrical equipment shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain electrical devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide power wiring for these devices. Enclosures suitable for the environment shall be furnished. Electrical equipment in hazardous areas shall be suitable for and rated for use in the particular hazardous or classified location in which it is to be installed.

2.5 SEISMIC RESTRAINT

A. The construction area is classified by the International Building Code (IBC) as Seismic Class C. The Code requires that not only the structures, but also major electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most recent adopted edition of the IBC, and the Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA) "Guidelines for Seismic Restraints of Electrical Systems".

B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.

C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than IBC requirements and SMACNA guidelines.

D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. After completion of shop assembly, factory test, and approval, equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.

B. Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package.

D. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 MANUFACTURER'S SERVICES

A. Manufacturer's services shall be furnished for the following equipment:
   1. Vendor supplied equipment that contain programmable controllers, operator interfaces and/or instrumentation that requires site calibration.
   2. Equipment that is equipped with VFD's
   3. Grinder and Grinder Controls System

3.3 INSTALLATION

A. The Electrical System indicated throughout the design is diagrammatic and therefore locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Contractor shall make such changes without additional cost to the Owner.

B. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.

C. The alignment of equipment and conduit shall be adjusted to accommodate architectural changes, or to avoid work of other trades, without extra expense to the Owner.

D. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

E. The Electrical Contractor shall layout and install electrical work prior to placing floors and walls. Furnish and install sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

F. The Electrical Contractor shall furnish and install inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, sleeves, or other mounting hardware are improperly placed, or installed, the Contractor shall do necessary work, at their own expense, to rectify the errors.

G. The Electrical System is integrally connected to I&C, mechanical and structural systems. Coordinate with these other disciplines the installation of these related components.

H. Electrical equipment shall be anchored by methods that comply with seismic requirements applicable to the Site.

I. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that Work. Such changes shall not be a basis of claims for extra Work or delay.

J. Instrumentation, control panels, wiring and all other I&C equipment shall be properly tagged and/or labeled per the requirements of Section 260553.

K. Installation of the I&C System shall be according to the finalized Loop Drawings

3.4 FACTORY ACCEPTANCE TESTING (FAT)

A. The IS shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the Engineer and Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the Engineer prior to testing. No shipments shall be made without the Engineer's approval.

B. For each FAT, the IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. The FAT Plan and Procedure shall as a minimum shall have the following:
   1. Descriptions of test methods to be performed during the FAT.
   2. FAT Schedule and Procedure
   3. FAT Checklists that allow for sign-off and comments for each test method and procedure.

C. Control Panel Completion Test Methods: The following test methods should be performed during the FAT for each control panel:
   1. Completed Shop Drawings: Demonstrate that the control panel has been built according to the shop drawings and that the shop drawings are accurate.
   2. Panel Layout: Demonstrate that the control panel has been laid out as designed and as required by Division 40.
   3. Power Distribution: Demonstrate all power distribution circuits, including but not limited to AC power circuits, UPS operation, signals and circuits and DC circuits.
   4. Control Circuits: Demonstrate the correct installation of each control circuit. Using a signal generator or multi-meter, show the correct operation of each input, output, relay, barrier, buttons, switches, or any other control device. Demonstrate the proper functionality of any hard-wired interlocks that may be associated with each control circuit.
   5. Panel Networking/Communications: If any form of communications is associated with the control panel, verify the proper operation of each communication port and link.

D. Control Loop Test Methods: In order to demonstrate that the control panel will provide its function as intended, provide the following control loop test methods. If programming for the control panel is provided by others, coordinate with the programmer to have all programming completed and tested prior to the FAT. If needed, coordinate to have the programmer present for the FAT.

1. Alarm Functions: Verify and/or simulate each alarm condition associated with each control loop.
2. Local Manual and Auto Functions: Verify and/or simulate each Local Manual and/or Auto function associated with each control loop.
3. SCADA Manual and Auto Functions: Verify and/or simulate each SCADA Manual and/or Auto function associated with each control loop.
4. Control Loop Interlocks: Demonstrate the functionality of any software interlocks that may be associated with each control loop.

E. If the FAT does not pass and needs to be repeated, the IS shall be responsible for additional per diem costs incurred by the Engineer and Owner.

F. All changes and/or corrections made during the FAT shall be noted on the checklists.

G. Following completion and approval of all FAT, provide the finalized checklists to the Engineer and as part of the equipment shop drawings.

3.5 FIELD QUALITY CONTROL

A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

3.6 CALIBRATION

A. Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.

C. Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

D. Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.

F. For each instrument calibration, provide a calibration sheet and update the corresponding TR20 Instrument Form with the new calibration data. The Calibration sheet shall include the following as a minimum:
   1. Date of calibration
   2. Project Name.
   3. Tag Number.
   4. Manufacturer, model and serial number.
   5. Calibration data including range, input, output and measurement at each calibration point.
   6. Space for comments.
   7. Space for sign-off by party performing calibration.

G. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The IS shall sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.7 LOOP TESTING

A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
   1. All associated equipment, conduit and wire has been permanently installed, terminated and inspected.
   2. All wiring has been properly pulled, terminated and labeled.
   3. Each wire has been tested with a point-to-point test.
   4. All control panels and electrical equipment have been checked out and tested as required by Division 26.
   5. All instrumentation has been appropriately installed and calibrated.
   6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.

B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
   1. Loop Number and Description
   2. Check-Off List with room for sign-off and dated by the IS, Programmer, and Owner's Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
      a. Each power distribution circuit.
      b. Each control circuit.
      c. Each alarm circuit.
      d. Each PLC input/output point.
      e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
      f. Each hard-wired and software interlock.

C. Upon completion of the above pre-requisites for loop testing, the IS shall oversee and coordinate each loop test. The IS is responsible to be present for all loop testing, whether the equipment was supplied by the IS or not. The IS is responsible to have all responsible parties associated with each loop present. This includes but is not limited to manufacturer representatives, vendor technicians, electrical installers, mechanical installers, and programmer. The IS shall coordinate with the Owner and Engineer to allow for witnessing of loop testing as deemed necessary by the Owner and Engineer.

D. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays. Any costs associated with re-testing and requiring all parties to return to the site shall in no way be incurred to the Owner.

E. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.

F. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

3.8 COMMISSIONING

A. The IS shall oversee, coordinate and be present during all commissioning activities. The IS shall be responsible for obtaining the assistance of the Contractor and Subcontractors as may be required for commissioning activities.

B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

C. Commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system commissioning and test requirements have been satisfied.

D. Where feasible, system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software-based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

E. Electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

3.9 TRAINING

A. Provide training in accordance with Section 260000.

B. Develop a Training Plan for the training requirements of Division 40 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of each training session. Schedule the trainings for after the equipment has been pre-commissioned.

C. As part of the Training Plan, submit a résumé for each individual to be providing training. Training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

D. Each training session shall include a written agenda.

E. The Contractor shall train the Owner's personnel on the maintenance, calibration and repair of instruments provided.

F. Within 10 days after the completion of each session, the Contractor shall submit the following:
1. A list of Owner personnel who attended the training.
2. A copy of the training materials used during the session with notes, diagrams and comments.

END OF SECTION 260000

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. All conductors, conductor insulation and multiconductor cables shall comply with NEMA WC 70.

B. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors #6 AWG or smaller shall be THWN-2 or XHHW-2. Number 4 and larger shall be XHHW-2.

C. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600V.

D. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than #12 AWG, unless specifically noted on the Plans. Control wires shall be allowed to be #14 so long as there is appropriate protection (fuse or circuit breaker sized at 15A or less).

E. Multi-conductor tray cables shall be rated 600 volts, listed by UL as Type TC cable or ITC for instrumentation cable only per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/Terminators shall be watertight and manufactured of the same material as the cabling system referenced elsewhere in division 26.

F. Multi-conductor tray cables to be installed in classified areas shall be armored, rated 600 volts, listed by UL as Type MC-HL cable per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/terminators shall be rated for classified areas and submitted upon accordingly.

G. All wiring shall be as indicated on the Plans. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

H. VFD Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
3. Comply with UL requirements for cables in direct burial or Classes I and II, Division 2 hazardous location applications.

I. The following table describes the conductor color code that shall be followed:

	120/208VAC	**480VAC**	**12VDC**	**24VDC**	**24VAC**
Phase 1	Black	Brown			
Phase 2	Red	Orange			
Phase 3	Blue	Yellow			
Neutrals/Commons	White	White	Orange/White	Blue/White	Yellow/White
Ground	Green	Green	Green	Green	Green
Control	Red		Orange	Blue	Yellow

J. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Insulated Wire Corporation
2. Cablec Corporation

3. Okonite Company
4. Southwire Company
5. Or Approved Equal

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

B. Connectors and splices shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

C. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.

D. Splices in wires No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

E. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

F. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Power Systems, Inc.
2. O-Z/Gedney; EGS Electrical Group LLC.
3. 3M; Electrical Products Division.
4. Or Approved Equal

2.3 PULLING LUBRICANT

A. All cables shall be properly coated with a water-based (wax-based is not acceptable) pulling compound before being pulled into conduits so as to prevent mechanical damage to the cables during installation. Lubricants shall be approved by the cable manufacturer for use with the cable being installed.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Polywater
2. Ideal Aqua-Gel
3. Or Approved Equal

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper, stranded for all sizes.

B. Branch Circuits: Copper. Stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway

B. Exposed Feeders and Branch Circuits: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway. Multiconductor Tray Cable type TC shall be used where runs are to be in cable trays as shown on the drawings.

C. Feeders and Branch Circuits Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway. Metal-clad cable, Type MC shall be allowed in ceilings that are considered dry and non-corrosive areas.

D. Feeders and Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway.

E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

F. Class 1 Control Circuits: Type THWN-2, in raceway. Multiconductor Tray Cable type TC shall be used where runs are to be in cable trays as shown on the drawings.

G. Class 2 Control Circuits: Type THWN-2, in raceway. Power-limited tray cable shall be used where runs are to be in cable tray as shown on the drawings.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval. Conductor splices shall not be made in underground junction boxes or manholes unless specifically noted on the plans.

C. Each feeder and branch circuit shall be installed in its own individual conduit unless combining feeder and branch circuits is permitted as defined in the following:

1. As specifically indicated on the Plans.

2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity de-rated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.
3. When field conditions dictate, and written permission is obtained from the Engineer.

D. Use manufacturer-approved pulling compound or lubricant when pulling conductors; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted above. 12VDC, 24VDC and 48VDC control circuits may be combined into one conduit. 120/208/240VAC control circuits shall be isolated from all DC control circuits. 277/480VAC circuits shall be isolated from all other voltages.

G. Single conductor cable in cable trays shall be No. 1/0 or larger and shall be of a type listed and marked for use in cable trays. Tray cable smaller than 1/0 shall be multi-conductor, with outer jacket.

H. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

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

J. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

K. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

L. 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 and UL 486B.

M. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

N. Wiring at Outlets and Switches: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

   a. All conductors with voltages at 277V or higher and corresponding neutrals and grounds.

   b. All conductors #8 and larger.
   c. All motor leads and corresponding grounds.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

   a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
   b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Instrumentation cabling.
2. Low-voltage control cabling.
3. Control-circuit conductors.
4. Identification products.

B. Related Sections

1. For structured cabling systems, including fiber optic cabling and CAT6 cabling refer to Section 409533.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

B. Test each pair of each cable for open and short circuits.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Conduit and Boxes: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Plans and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.

B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

C. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

E. Pairs installed in a cable tray shall have a UV resistant jacket, and shall have a jacket intended for cable tray use.

2.3 RS-232 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.4 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

C. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.

2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

D. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.6 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.7 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Panduit Corp.
3. Or Approved Equal.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 12 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 24 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 48 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 6 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: 3 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

5. Separation between Cables and Electrical Motors and Transformers: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 6 inches.

3.3 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. For data communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 260523

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Grounding systems and equipment.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Stranded Conductors: ASTM B 8.
2. Tinned Conductors: ASTM B 33.
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

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.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch in diameter and 10 feet long.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductors all conductor sizes.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded or approved compression 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 the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

E. 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 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.

2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems”, and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least two test wells for each service unless otherwise indicated. Install at the ground rods electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 LABELING

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

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, and at ground test wells. Make tests at ground rods before any conductors are connected.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 ACTION SUBMITTALS

A. Product Data: For steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.; a division of Cooper Industries.
    c. ERICO International Corporation.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut; Tyco International, Ltd.
    g. Wesanco, Inc.

3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
6. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel or Stainless Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.

7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install conduits as required, and as shown on the Plans. Materials employed shall be as shown on the Plans.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. If changes from the Plan are proposed, shop drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

C. Proposed routing of conduits buried under floor slabs-on-grade.

D. Identify conduit by tag number of equipment served or by circuit schedule number.

E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc.

F. Proposed location and details of construction for openings in slabs and walls for raceway runs.

G. Refer to Section 26000 “General Electrical Requirements” for further submittal requirements.

1.3 REFERENCES

A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.

B. National Electric Manufacturers Association (NEMA): RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

C. Underwriters Laboratories Inc. (UL):

1. 1, Flexible Metal Conduit.
2. 6, Rigid Metal Conduit.
3. 360, Liquid-Tight Flexible Steel Conduit.
4. 467, Grounding and Bonding Equipment.
5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.
6. 651, Schedule 40 and 80 Rigid PVC Conduit.
7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
8. 884, Underfloor Raceways and Fittings.
9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Exposed conduits in an unclassified or non-hazardous area shall be Galvanized Rigid Steel (GRS) unless specifically indicated otherwise on the Plans. Conduits in corrosive, hazardous, or damp areas shall be PVC coated GRS unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All conduits concealed in block walls or steel framing shall be EMT with compression fittings unless otherwise indicated. Set screw type fittings in EMT conduit will not be accepted. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground conduit shall be less than one inch.

B. Condulets type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors, damp or wet locations shall be weather tight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout. Conduit systems shall be water tight.

E. Expansion fittings shall be OZ type AX with jumper for exposed locations and type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

G. Sealing fittings shall be provided for classified areas per the NEC requirements in hazardous or corrosive areas. Fittings shall be poured after the final walk-thru unless otherwise directed in writing by the engineer.

2.2 GALVANIZED RIGID STEEL (GRS)

A. Conduits and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. Instead buried steel conduit shall be PVC coated.

2.3 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

A. PVC coated GRS conduit shall be installed where shown on the Plans or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 standards.

B. The zinc surface of the conduit shall remain intact and undisturbed on both the inside and the outside of the conduit throughout the preparation and application processing. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).

C. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2 inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.055-inch (55 mil).

D. A PVC coating shall be bonded to the inner and outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be completely interchangeable. The inside of conduit bodies shall remain undisturbed in the processing.

E. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.

F. Conduit straps shall be PVC coated or stainless steel.

G. PVC coated conduits and fittings shall be as manufactured by Kor Kap Corporation, Occidental Coating Company, Rob-Roy, or equal.

H. PVC coated flexible conduits shall be liquid and vapor-tight and manufactured in accordance with UL 360 standards.

2.4 RIGID NONMETALLIC – PVC

A. Where specifically indicated on the Plans, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Plans, conduit supports shall be installed at five-foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquidtight flexible metal conduit shall be liquid and vapor-tight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors and PVC coated fittings shall be utilized.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduits and connectors for 1 1/4 " and smaller shall be listed for grounding.

D. For non-corrosive locations, connectors for liquidtight flexible conduit shall be galvanized, furnished with a sealing ring and locknut, and suitable for wet locations. For corrosive locations, connectors shall be galvanized PVC coated.

2.6 ELECTRICAL METALLIC TUBING (EMT)

A. Per UL Standard for Electrical Metallic Tubing No. 797. Galvanized mild steel with interior coat of enamel.

B. Fittings shall be steel set-screw type. Cast type, indenter type or compression steel fittings are not acceptable.

C. Approved for plan specified locations only. Approved for conduits concealed in block walls and concealed in steel framed walls. Not approved for process areas where wash down or high humidity conditions exist.

2.7 ALUMINUM CONDUIT

A. Aluminum conduit is approved for wet and corrosive areas only. Prior approval from the engineer must be obtained when substituting for PVC coated.

B. Aluminum hardware and conduit shall be isolated from all dissimilar materials as appropriate.

1. Isolation from dissimilar metals in channel or support by a single layer of scotch #33+ or approved equal.
2. Isolation from concrete shall be by neoprene gaskets.
3. Aluminum shall not be used for concrete penetrations.

C. Aluminum conduit shall contain less than 0.4% copper.

2.8 STAINLESS STEEL CONDUIT

A. Stainless Steel Conduit conduit is approved for all exposed conduit locations. Prior approval from the engineer must be obtained when substituting for PVC coated.

B. Stainless Steel conduit and all fittings and support hardware shall be 316 SS.

2.9 CABLE TRAY SYSTEM

A. Provide cable tray systems composed of straight sections, fittings, and accessories as defined in the latest NEMA Standards publication VE-1 - Ventilated Cable Tray.

1. Provide cable trays and fittings shall constructed of materials suited for the area classification as noted below.
2. Provide cable trays shall be of the ladder type with availability of 6, 9, and 12-inch spacing.
3. Provide tray sizes with a 3, 4, 5, or 6-inch minimum usable load depth, as indicated on the drawings.
4. Provide loading capacities that meet the NEMA weight classification with a safety factor of 1.5.
5. In corrosive, damp, or Hazardous locations, provide cable trays manufactured of aluminum.
6. In non-classified areas provide cable trays manufactured of Hot Dipped galvanized materials. All cuts and welds shall be touched up with cold galvanizing spray per the raceway specification.
7. Separate power, control, signal and communications cables by grounded metallic dividers or run in separate trays.
8. Manufacturer, or Approved Equal

a. Husky
b. B-Line
c. T.J. Cope

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the condulet type.

D. Conduit runs in buildings and structures shall be concealed where possible except as specifically noted, or accepted by the Engineer.

E. Conduit runs shall not interfere with the proper and safe operation of equipment, and shall not block or interfere with ingress or egress, including equipment removal hatches.

F. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit to vibrating equipment such as motors, fans, and transformers. The maximum length of flexible conduit shall be 3 feet, unless approved in writing by engineer. Flexible conduit shall not be used for electrician's convenience where rigid conduit could be used.

G. Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel galvanizing, or other coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

H. Conduit shall be thoroughly reamed to remove burrs. IMC or GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads.

I. Bushings and lock nuts or hubs shall be used at conduit terminations. Conduit, bushings, locknuts, and enclosures shall be fastened to the conduit system prior to pulling wire. Splitting the bushings for installation will not be accepted. Hubs shall be used in all process areas outside of electrical rooms unless otherwise specified. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string. Splices shall be made in junction boxes only. Splices in conduit bodies will not be accepted.

J. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

K. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

L. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used. Test results should be submitted to the engineer.

M. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

N. Provide trenching, backfill, and compaction for conduits installed underground.

O. Raceways running parallel to hot water or steam piping shall maintain a distance of 6 inches from the piping.

P. Raceways crossing steam or liquid filling piping shall cross above the piping.

Q. In slab conduits, shall be covered by a minimum of 2 inches of concrete.

R. Conduits of the same duty (480V Power, 120V Power, 120V Controls and signals) shall have a minimum separation of 2 inches between conduits.

S. Conduits and raceways carrying signal wiring shall have a minimum separation of 12 inches from 480V power raceways, 6 inches from 120V power raceways, and 4 inches from 120V control raceways.

T. Raceways with 120V Control shall maintain a distance of 12 inches from 480V power raceways, 6 inches from 120V power raceways.

U. Raceways with 120V power shall maintain a distance of 6 inches from 480V power raceways.

3.2 CABLE TRAYS

A. Provide cable trays in strict accordance with the manufacturer's printed instructions.

B. Allowable cable fill areas shall meet NEC Article 392 - Cable Trays requirements.

C. Verify cable tray fills prior to installation based on cables and trays actually provided.

D. Maintain continuous grounding of cable trays including bonding jumpers in accordance with the requirements of NEC Article 392.

E. Install cable trays using hangers and supports on 8-foot centers, maximum.

F. Install cable trays to walls as the primary method of support where possible.

G. If support from the ceiling is the only alternative, use hangers and supports on 6-foot centers, maximum.

H. Ensure that proper separation between duties as detailed in 3.1.

END OF SECTION 260533

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260534 – ENCLOSURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve as junction boxes where shown on the Drawings.

1.2 RELATED SECTIONS

A. For Raceways and Boxes for Electrical Systems see Section 260533 "Raceways and Boxes for Electrical Systems".

1.3 SUBMITTALS

A. Products shall be submitted in accordance with Section 26000 "General Electrical Requirements", and elsewhere in the Contract Documents, prior to installation.

1.4 MANUFACTURERS

A. Enclosures shall be manufactured by Hoffman, Rittal, or equal.

PART 2 - PRODUCTS

2.1 STEEL

A. Enclosures shall be fabricated from 14-gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these specifications.

C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Plans should be checked for special conditions.

2.2 NEMA RATING

A. Unless otherwise indicated on the Plans, enclosures shall be NEMA 12 for indoors, NEMA 4X for corrosive areas, and NEMA 4 for outdoor installations. NEMA 4X enclosures shall be stainless steel, unless noted otherwise. NEMA 4X enclosures shall also be used in wet, or wash down areas.

B. All enclosures used in classified areas shall be NEMA 7.

C. In Waste Water facilities, all enclosures in process areas shall be NEMA 4X stainless steel. Enclosures in electrical rooms, meeting rooms, offices and shops shall be NEMA 12 unless otherwise specified.

D. Areas not specified in Water Treatment, Wastewater, or other water related facilities shall be approved by the engineer for NEMA type prior to installation.

2.3 FIBERGLASS

A. Enclosures shall be heavy-duty, compression molded, fiberglass reinforced polyester, high impact, heat resistant, NEMA 4X.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Enclosures shall be installed as indicated on the Plans, and according to manufacturer's instructions.

B. Enclosures shall be properly grounded, and shall include ground straps connected to hinged doors and accessories.

END OF SECTION 260534

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ladder cable trays.
2. Single-rail cable trays.
3. Trough cable trays.
4. Fiberglass cable trays.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of cable tray.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.0.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.3 LADDER CABLE TRAYS

A. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 6 inches (150 mm)
3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 6 inches (150 mm).
8. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
9. Width: 9 inches (225 mm) unless otherwise indicated on Drawings.
10. Fitting Minimum Radius: 12 inches (300 mm)
11. Class Designation: Comply with NEMA VE 1, Class 12B.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 SINGLE-RAIL CABLE TRAYS

A. Description:

1. Configuration: Center rail with extruded-aluminum rungs arranged symmetrically about the center rail.
2. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
3. Rung Spacing: 6 inches (150 mm)
4. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
5. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
6. Width: 9 inches (225 mm) unless otherwise indicated on Drawings.
7. Support Point: Splice fittings shall be hanger support point.

8. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
9. Loading Depth: 4 inches (100 mm)
10. Maximum Loads: 25 lb/ft. (37 kg/m)
11. Unbalanced Loads: Maintain cable tray rungs within six degrees of horizontal under all loading conditions.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316.
15. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.

2.5 TROUGH CABLE TRAYS

A. Description:

1. Configuration: Two longitudinal members (side rails) with a solid sheet over rungs exposed on the interior of the trough, or corrugated sheet with both edges welded to the side rails.
2. Rung Spacing: Rungs or corrugations shall be spaced a maximum of 6 inches (150 mm) o.c. and have a minimum flat bearing surface of 2 inches (50 mm).
3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
5. Minimum Usable Load Depth: 4 inches (100 mm)
6. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
7. Width: 9 inches (225 mm) unless otherwise indicated on Drawings.
8. Fitting Minimum Radius: 12 inches (300 mm).
9. Class Designation: Comply with NEMA VE 1, Class 12B.
10. Splicing Assemblies: Bolted type using serrated flange locknuts.
11. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
12. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316.

2.6 FIBERGLASS CABLE TRAYS

A. Description:

1. Configuration: Two longitudinal members with rounded edges and smooth surfaces, complying with NEMA FG 1.
2. Materials: Straight section structural elements; side rails, rungs and splice plates shall be pultruded from glass-fiber-reinforced polyester resin, complying with NEMA FG 1 and UL 568.
3. Fasteners: Fiberglass-encapsulated, ASTM F 593 and ASTM F 594 stainless steel, Type 316. Design fasteners so that no metal is visible when fully assembled and

tightened. Fastener encapsulation shall not be damaged when torqued to manufacturer's recommended value.

4. Minimum Usable Load Depth: 5 inches (125 mm) according to NEMA FG 1.
5. Straight Section Lengths: 10 feet (3 m)
6. Width: 9 inches (225 mm) unless otherwise indicated on Drawings.
7. Class Designation: Comply with NEMA VE 1, Class 12B.
8. Temperature Rating: Reduce the load rating of tray exposed to temperatures above 75 deg F (24 deg C) according to Table 4-3, "Working Loads," in NEMA FG 1.
9. Fitting Minimum Radius: 12 inches (300 mm)
10. Splicing Assemblies: Minimum four nuts and bolts per plate. Splice plates shall be furnished with straight sections and fittings.
11. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.7 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Mill galvanized before fabrication.

    a. Hardware: Galvanized, ASTM B 633.

5. Finish: Electrogalvanized before fabrication.
6. Finish: Hot-dip galvanized after fabrication.

    a. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

7. Finish: Epoxy-resin paint.

    a. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

B. Aluminum:

1. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.
2. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

C. Stainless Steel:

1. Materials: Low-carbon, passivated, stainless steel, Type 316L, ASTM F 593 and ASTM F 594.
2. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.8 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Covers: Solid type made of same materials and with same finishes as cable tray.

C. Barrier Strips: Same materials and finishes as for cable tray.

D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.9 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA FG 1.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Fasten cable tray supports to building structure.

D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems. "Comply with seismic-restraint details according to Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

F. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

G. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.

H. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

I. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

J. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

K. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

L. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

END OF SECTION 260536

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260543 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
2. Handholes and boxes.
3. Manholes.

B. Related Requirements:

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

2. Specification Section 260533 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS apply to this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For accessories for handholes and boxes.

B. Shop Drawings for Factory-Fabricated Handholes and Boxes: Include dimensioned plans, sections, elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. PVC Coated Rigid Steel Conduit. Refer to Specification Section 260533-2.3A for requirements.

C. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.

    a. Color: Red dye added to concrete during batching.
    b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 HANDHOLES AND BOXES

A. Description: Comply with SCTE 77.

1. Color: Gray or Green, depending on location.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Resto-revegetation and include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 311000 “Finish Grading and Landscaping”.

D. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.2 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 3 inches between ducts for like services, and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 24 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Section 312000 " Earth Moving"
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 312000 " Earth Moving"
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.

9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

11. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.3 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and 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.

3.4 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.6 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 260543

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products 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."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

3. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Stainless steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

    a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using **steel** pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Channel support systems.
   2. Restraint cables.
   3. Hanger rod stiffeners.
   4. Anchorage bushings and washers.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

   1. Site class, building code and Design Spectral Response Acceleration as defined on the Contract Drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

   3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
    c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.

3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
6. Mason Industries.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.

E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
2. Test at least four of each type and size of installed anchors and fasteners selected by Engineer.
3. Test to 90 percent of rated proof load of device.
4. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 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.

1.2 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples of each color, lettering style and other graphic representation required for each identification material or system.

C. Table or list of equipment, panel and disconnect switch labels.

1.3 QUALITY ASSURANCE

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 materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 POWER 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:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive 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 adhesive tape for securing ends of legend label.

D. 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.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Write-On Tags shall not be allowed.

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 raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

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 raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label. Heat shrink tubing, or sleeve type wire markers are also acceptable.

A. Write-On Tags shall not be allowed.

B. Snap-Around Labels: 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.

C. Snap-Around, Color-Coding Bands: 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.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label. Heat shrink tubing, or sleeve type wire markers are also acceptable.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

D. Write-On Tags shall not be allowed.

2.5 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications 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.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft.
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

D. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.7 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 grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

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."

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. 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. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

A. 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. Overlay shall provide a weatherproof and UV-resistant seal for label.

B. 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.

C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.10 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 CONDUCTOR LABELING SCHEME

A. All control and instrumentation conductors shall be labeled with a “To/From” labeling scheme. Each conductor label shall have two lines of text. The first line of text shall indicate the enclosure and terminal where the wire is to terminate on the other end. The second line of text shall indicate the enclosure and terminal where the wire is to terminate on this end. The following example illustrates the “To/From” labeling scheme:
   1. A wire is connected between a VFD and an LCP. The VFD equipment tag is VFD-100 and the LCP equipment tag is LCP-100. The connecting terminal at the VFD enclosure is terminal “5”. The connecting terminal at the LCP is terminal “7”. This wire would have the following labels:
      a. The wire label at the VFD end:
         Top Line: “LCP-100 : 7”
         Bottom Line: “VFD-100 : 5”
      b. The wire label at the LCP end:
         Top Line: “VFD-100 : 5”
         Bottom Line: “LCP-100 : 7”

3.2 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. 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 maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.3 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Install labels at 10-foot maximum intervals.

B. 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.

C. 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 Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

a. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

b. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches 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.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. 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.

G. 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.

H. 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.

I. 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.

J. 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.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

L. 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: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

SECTION 260573 – ELECTRICAL TESTING WITH COORDINATION STUDY

PART 1 – GENERAL

1.1 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E. The arc flash hazard analysis shall be performed according to the IEEE 1583 equations that are presented in NFPA 70E-2004, Annex D.

C. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract as well as all existing distribution equipment at the customer facility.

D. The contractor shall perform electrical tests as described in Part 3 of this document.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):

    a. 450, Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generator Stations and Substations.
    b. C2, National Electric Safety Code.
    c. C37.13, Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
    d. C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
    e. C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear.
    f. C37.20.3, Metal-Enclosed Interrupter Switchgear.
    g. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
    h. C62.33, Standard Test Specifications for Varistor Surge Protective Devices.

2. American Society for Testing and Materials (ASTM):

    a. D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
    b. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
    c. D923, Standard Test Method for Sampling Electrical Insulating Liquids.
    d. D924, Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
    e. D971, Standard Test Method for Interfacial Tension of 0.1 against Water by the Ring Method.
    f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.

g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
h. D1500, Standard Test Method for ASTM Color of Petroleum Products.
i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
j. D1533, Standard Test Methods for Water in Insulating Liquids.
k. D1816, Standard Test Method for Dielectric Breakdown Voltage on Insulating Oils of Petroleum Origin Using VDE Electrodes.
l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin against Water by the Drop-Weight Method.

3. Institute of Electrical and Electronics Engineers (IEEE):

a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.
c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
d. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
e. 118, Standard Test Code for Resistance Measurement.
f. 141, Recommended Practice for Electric Power Distribution and Coordination of Industrial Power Systems.
g. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
h. 399, Recommended Practice for Industrial and Commercial Power System Analysis
i. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
j. 1015, Recommended Practice for Apply Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
k. 1584, Guide for Performing Arc-Flash Hazard Calculations

4. National Electrical Manufacturers Association (NEMA):

a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
b. PB 2, Deadfront Distribution Switchboards.
c. WC 7, Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
d. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

6. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.3 SUBMITTALS

A. Analysis Studies Submittal: Submit prior to receiving final approval of the distribution equipment submittal and prior to release of equipment manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval may be obtained from the Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report and submitted to the Design Engineer
2. The report shall include the following sections:
   a. Executive Summary
   b. Descriptions, purpose, basis and scope of the study
   c. Tabulations of circuit breaker, fuse and other protective device ratings versus short circuit duties
   d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trips unit settings, fuse selection
   e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout\
   f. Details of the incident energy and flash protection boundary calculations
   g. Recommendations for system improvements, where needed
   h. One-line diagram
3. Arc flash labels shall be provided in hard copy only
4. Sample copy of individual device test form.
5. Sample copy of individual system test form.

B. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.
2. List of references to be used for each test.
3. Sample copy of equipment and materials inspection form(s).
4. Sample copy of individual device test form.
5. Sample copy of individual system test form.

C. Quality Control Submittals: Submit within 14 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

D. Contract Closeout Submittals:

1. Operation and Maintenance Data:
   a. In accordance with references elsewhere in these specifications.
   b. After test of inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.4 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.

C. The Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The Engineer shall submit references of at least ten actual short-circuit, protective device coordination and arc flash hazard analysis studies performed over the last five years.

1.5 QUALITY ASSURANCE

A. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

B. Test instrument calibration shall be in accordance with NETA ATS.

1.6 SEQUENCING AND SCHEDULING

A. Perform short-circuit, protective device coordination and arc flash hazard analysis studies prior to final approval of distribution equipment submittal

B. Perform inspection and electrical tests after equipment has been installed.

C. Perform tests with apparatus de-energized whenever feasible.

D. Inspection and electrical tests on energized equipment are to be:
1. Scheduled with OWNER prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

E. Notify OWNER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 – PRODUCTS

2.1 STUDIES

A. Contractor is to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E Article 130.3 and Annex D.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:
1. Calculation methods and assumptions
2. One-line diagram of the system being evaluated
3. Source impedance data, including utility system and motor fault contribution characteristics
4. Tabulations of calculated quantities
5. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
1. Electric utility’s supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation
1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:
1. Electric utility's overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208-volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:
1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.

4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:
1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated fault current magnitude and angle
   c. Fault point X/R ratio
   d. Equivalent impedance
2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
   d. Calculated asymmetrical fault currents
   e. Equivalent impedance
3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   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

C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
   a. Current transformer ratio
   b. Current setting
   c. Time setting
   d. Instantaneous setting
   e. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground)
   b. Adjustable time-current characteristic
   c. Adjustable instantaneous pickup
   d. Recommendations on improved trip systems, if applicable.

D. 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. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 – EXECUTION

3.1 GENERAL

A. Tests specified in this section are to be performed in accordance with the requirements elsewhere in these specifications.

B. Coordination with local Utilities to obtain necessary information to perform the tests specified in this section is the responsibility of the Contractor. All costs incurred in obtaining required information shall be borne by the Contractor.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer’s tolerances.
2. All trip units are adjusted to avoid erroneous tripping of circuit breakers.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer’s recommendations.

D. Adjust mechanisms and moving parts for free mechanical movement.

E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents.

G. Realign equipment not properly aligned and correct un-levelness.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer’s recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Inform OWNER of working clearances not in accordance with NFPA 70.

M. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer’s instructions.
3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by OWNER, door and panel sections having dented surfaces.
5. Repair or replace, as determined by OWNER, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch up scratches and mars.
    b. If required due to extensive damage, as determined by OWNER, refinish the entire assembly.

O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

3.2 COORDINATION STUDY FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

3.3 ARC FLASH WARNING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:
1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
1. For each 600, 480 and applicable 208-volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.

3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

3.4 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 4 and Larger For:
    a. Physical damage.
    b. Proper connections in accordance with single-line diagram.
    c. Cable bends that do not conform with manufacturer's minimum allowable bending radius where applicable.
    d. Color coding conformance with specifications.
    e. Proper circuit identification.
2. Mechanical Connections For:
    a. Proper lug type for conductor material.
    b. Proper lug installation.
    c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
    a. Proper Shield grounding.
    b. Proper terminations.
    c. Proper circuit identification.
4 Control Cables For:
    a. Proper termination.
    b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.
    b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
    c. Insulation resistance values equal to, or greater than ohm values established by manufacturer.
    d. Provide test reports to Engineer and Owner that show where test measurements were taken and the results
2. Contact Resistance Tests:
    a. Contact resistance in micro-ohms across each switch blade and fuse holder.
    b. Investigate deviation of 50% or more form adjacent poles or similar switches.

3.5 MOLDED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 400 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.

3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Operate frame size and trip setting with circuit breaker schedules or one-line diagram.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohm-meter for 480- and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 10.2.
2. Contact Resistance Tests:
   a. Contact resistance in micro-ohms across each pole.
   b. Investigate deviation of 50% or more from adjacent poles and similar breakers.
3. Trip Coordination Study:
   a. Provide coordination study of all new and existing equipment in the facility.
   b. Adjust all circuit breaker settings per the coordination study.

3.6 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers for:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically that:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.7 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify that meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.8 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control centers and panelboards assemblies for proper connection and tightness.
2. Ground bus connections in motor control centers and panelboards assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled, and proper bonding was obtained.
6. Test ground system using 3-point fall of potential test equipment. Ground system must provide less than 5 ohms to ground resistance. Provide test reports to Engineer and Owner that show where test measurements were taken and the results. System must be tested at all ground rods, concrete encased electrodes, ground busses and service entrance locations.

3.9 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 10 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate Motor and Check for:
    a. Excessive mechanical and electrical noise.
    b. Overheating.
    c. Correct rotation.
    d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for proper operation.
    e. Excessive vibration.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
    a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
        1) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
        2) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
    b. Insulation resistance values equal to, or greater than, ohm values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer’s instructions.
4. Measure running current and voltage and evaluate relative to load conditions and nameplate full-load amperes.

5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

3.10 LOW VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of draw out elements.
6. Integrity and contamination of us insulation system.
7. Check Door and Device Interlocking System By:
    a. Closure attempt of device when door is in OFF or OPEN position.
    b. Opening attempt of door when device is in ON or CLOSED position.
8. Check Nameplates for Proper Identification Of:
    a. Equipment title and tag number with latest one-line diagram.
    b. Pushbuttons.
    c. Control switches.
    d. Pilot lights.
    e. Control relays.
    f. Circuit breakers.
    g. Indicating meters.
9. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify that current and potential transformer ratios conform to Contract Documents.
11. Check Bus Connections for High Resistance by Low Resistance Ohmmeter and Calibrated Torque Wrench Applied to Bolted Joints:
    a. Ohm value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
13. Verify performance of each control device and feature furnished as part of the motor control center.
14. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect Contactors For:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of all connections.
17. Compare overload heater rating with full-load current for proper size.
18. Compare fuse, motor protector, and circuit breaker with motor characteristics for proper size.

19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.
   b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
   c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
   d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
   e. Test values to comply with NETA ATS, Table 10.2.
2. Current Injection through Overload Unit at 300% of Motor Full-Load Current and Monitor Trip Time:
   a. Trip time in accordance with manufacturer's published data.
   b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
   a. Apply secondary voltage to control power and potential circuits.
   b. Check voltage levels at each point on terminal boards and each device terminal.
   c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.
      1) Insulation resistance to be 1 megohm minimum.
4. Operational test by initiating control devices to affect proper operation.
5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

END OF SECTION 260573

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section covers electrical panelboards.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 26 00 00, and the Contract Documents, prior to installation.

B. Panel layout with alphanumeric designation, branch circuit breaker sizes and types, AIC rating, bus sizes, bus material and other characteristics.

1.3 QUALITY ASSURANCE

A. NEMA PB-1, Panelboards

B. NEC

C. UL67, Panelboards

PART 2 - PRODUCTS

2.1 PANELBOARDS

A. Dead-front panelboards, including lighting distribution and control panels, shall be furnished and installed as indicated on the Plans. Buses shall be tin-plated copper. If shown on the drawings as 4 wire, neutral shall be 100% rated. Mounting and type of enclosures shall be as indicated on the Plans. Where not indicated, indoor enclosures shall be NEMA 12 and outdoor enclosures shall be NEMA 4. The minimum interrupting capacity of any device shall be 22 KAIC unless otherwise indicated on the Plans.

B. All lighting panels shall have surge protection devices.

C. Protective devices shall be replaceable without disturbing adjacent units and shall be of the bolt-on type. Snap in protective devices will not be accepted. Wire connectors shall be suitable for wire sizes indicated. Branch circuits shall be numbered as indicated on the Plans, and a complete typed circuit schedule shall be furnished under a transparent cover and affixed to the inside of the panel access door. Phase busing shall be full height without reduction. Full size neutral and ground bars shall be included and shall have suitable lugs for each outgoing circuit requiring connection. Spaces for future protective devices provided in lighting panels shall be bused for the maximum device that can be fitted into them.

D. Panelboards shall be finished with a primer, rust resistant phosphate undercoat and two coats of oven baked enamel with finish ANSI grey. They shall be sized to provide a minimum of 4 inches of gutter space on all sides. Doors shall not uncover any live parts and shall be hinged and have latches that require no tool to operate. Panelboard doors shall be lockable. Lock and two keys shall be furnished.

E. Each panelboard shall have, on the outside of the door, a lamicoid nameplate with ¾-inch letters as specified elsewhere in these Contract Documents.

F. Panelboards shall be as manufactured by Square D, General Electric, Eaton / Cutler Hammer, or equal.

G. Panelboards shall be service entrance rated where required, and as shown on the Plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Panelboards shall be installed as indicated on the plans and according to manufacturer's instructions.

B. Provide grounding per NEC, and Section 260526.

C. Contractor shall verify all NEC clearance requirements prior to installation.

END OF SECTION 262416

SECTION 262419 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish and install, ready to use, motor control centers for use as indicated on the Contract Drawings and specified herein.

B. Circuit breaker ratings, and modifications, shall be as indicated on the Contract Drawings.

C. MCP ratings, and modification, shall be as indicated on the Contract Drawings.

1.2 SUBMITTALS

A. The motor control centers shall meet the requirements of the latest edition of Standards for Industrial Control No. ICS published by the National Electrical Manufacturers Association. The following minimum information and drawings shall be submitted for review:

1. Plan, front, side views and overall dimension of each motor control center.
2. Weight.
3. Internal wiring diagram of each plug-in unit.
4. Internal wiring diagram of the motor control centers.
5. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
6. One-line and schematic diagram for each motor control center.
7. Bill of material list and Manufacturer's Product Data.
8. Installation instructions including seismic installation.
9. Manufacturer's certification that the following items are capable of interrupting and/or withstanding the specified short circuit condition:
   a. Bus bar bracing
   b. Feeder tap units
   c. Starter units

B. Product information shall be submitted in accordance with Section 26 00 00 “General Electrical Requirements”, and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.1 MOTOR CONTROL CENTERS (MCC)

A. The motor control center fabricator shall be the manufacturer of the major components therein, such as circuit breakers and starters. Engineered motor control centers shall be by the component and housing manufacturer. The manufacturer shall comply with equipment specifications contained elsewhere in these Contract Documents.

B. Each component, as well as the complete assembly, shall be constructed and tested in accordance with latest NEMA Standards for Industrial Control. The type of construction of the control centers shall be NEMA Class II, Type B. Lifting eyes shall be provided on each section to facilitate handling.

C. Unit doors shall be mounted on the stationary structure and hinged on the side away from the vertical wireway. They shall be held closed with slotted thumbscrews.

D. Unit doors shall have positive action linkage with disconnect operating mechanism. Mechanism shall be designed so that it can be locked in the OFF position with up to 3 padlocks. When the handle is not padlocked, it shall be possible to open the door by releasing the door interlock with a small screwdriver. The control units shall be of the plug-in type. When doors are closed, the operating mechanism shall clearly indicate the ON or OFF position of the disconnect, and the door interlock mechanism shall engage. The disconnect operating mechanism shall be designed against inadvertent operation when the door is open. Each plug-in unit door shall be provided with a nameplate, specified elsewhere herein, that indicates the circuit number and circuit name. The nameplate shall be attached to the door with stainless steel screws. Each motor starter door shall be provided with an externally operated manual reset pushbutton for the overload relay.

E. It shall be possible to install up to 6 NEMA size one units in one vertical section. Units shall be completely enclosed with sheet steel. A small wireway shall be provided inside the unit, so all wiring can be laid in place without removing barriers or plates. Each vertical section that holds the units shall be rigidly formed of minimum 12 gauge, cold-rolled sheet steel. The vertical front-of-board-construction shall be supplied with minimum 20-inch depth.

F. Continuous horizontal wiring troughs shall be provided at both top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the MCC. A large continuous, full-height vertical wiring trough shall be provided in the right side of each section.

G. All starter wiring, control, and power shall be terminated in terminal strips in this trough for size 2 and smaller starters. Size 3 and larger starters shall have control leads terminating on the terminal strips in the trough. Terminal strips shall be split-type to facilitate wiring connections without disconnecting factory or field conductors. Terminal strips shall be rated to accept conductor sizes as indicated on the Contract Drawings.

H. All bus bars shall be tin plated copper, and shall be of the ampacity indicated on the Contract Drawings. Unit bus bar stabs shall insure high contact pressure. The vertical bus bars shall be effectively isolated from accidental contact by plastic insulating medium.

I. Bus bar supports shall be of high impact strength non-carbonizing insulating material mounted on padded steel brackets and shall provide adequate dielectric strength and creepage distance. The bus structure shall be capable of withstanding short circuit current in accordance with NEMA standards, and as indicated on the Contract Drawings.

J. Each section shall be equipped with horizontal ground bus that shall be continuous across the MCC.

K. The MCCs shall be supplied as indicated on the Contract Drawings, and as specified herein and in accordance with NEMA Standard Pub. IS 1.1, latest edition. The MCCs shall be enclosed in NEMA Type 1 gasketed industrial use enclosures, unless otherwise shown.

NEMA 3R enclosures shall provide sufficient depth for air conditioning units to be mounted on the end of the structures. If the MCCs contain VFDs or Solid State Starters that require cooling, their respective sections shall be louvered top and bottom, and fans shall remove heat from within the sections.

L. All metal surfaces and structural parts shall be given a phosphatizing, or equal, treatment prior to painting. The control centers shall then be given a gun-metal gray undercoat which is equal to zinc chromate. The exterior of the enclosure shall be finished in standard ANSI Grey.

M. Spaces for future combination starters shall have all the hardware necessary so that a future plug-in control unit can be installed without having to modify the vertical sections. The number of spaces for future control units shall be as indicated on the Contract Drawings.

N. Devices, such as, but not limited to, starters, circuit breaker, relays, timers, conductors, shall conform to other sections of these Contract Documents.

O. Provide customer metering instruments, as indicated on the Contract Drawings. Unless otherwise indicated on the Contract Drawings, metering units shall be electronic, capable of displaying volts line-to-line and line-to-neutral, and amps per phase.

P. Each section shall be equipped with horizontal neutral bus that shall be continuous across the MCC if the MCC is designated as 277/480 volt 4 wire.

Q. MCCs for this project shall be an intelligent MCC assembly with smart starters and VFD's each with an Ethernet port and support for monitoring and control over the Ethernet/IP protocol. Due to the variance in methods for implementing smart starters and VFDs, the schematics shown in the Contract Drawings shall be used as a guide in developing the actual schematics based upon actual vendor information. Each intelligent MCC shall be equipped with Layer 2 managed switches powered by a redundant DC power supply system. The connection from the plant SCADA network to the MCC shall be from a single CAT6 connection. Provide a minimum of four spare copper Ethernet ports for future connections.

Q. MCCs shall be as manufactured by Allen-Bradley, Eaton or Square D.

PART 3 - EXECUTION

3.1 GENERAL

A. The MCCs shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

B. Cables larger than No. 6 AWG, which hang from their vertical connections, shall be supported within 2 feet of the connection.

C. The motor overload relays shall be provided and sized based on the actual full load amperes of the motor connected to the starter.

D. The motor circuit protectors shall be adjusted to the lowest settings that do not cause false tripping.

E. Motor control centers shall be installed for seismic requirements as required in division 260000 "General Electrical Requirements".

F. Motor Control Centers shall be provided in accordance with all applicable sections of division 260000.

3.2 FIELD TESTS

A. MCCs shall be tested in accordance with Section 260000.

END OF SECTION 262419

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.
6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Appleton Electric Co. (Appleton).
2. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
3. Cooper Crouse-Hinds (Crouse-Hinds).
4. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
5. Killark.
6. Leviton Mfg. Company Inc. (Leviton).
7. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, 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.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES FOR UNCLASSIFIED AREAS

A. General Description

1. Convenience Receptacles, 125 V, 20 A
2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
3. Straight blade, grounding type, specification grade.
4. Color: White unless Owner or Engineer specifies otherwise. Ivory for weather resistant receptacles. Yellow for corrosion resistant receptacles.
5. Provide weather resistant receptacles for damp and wet areas (including all process areas or areas that may be sprayed down).
6. Provide corrosion resistant receptacles for corrosive areas.

B. Products: Subject to compliance with requirements, provide the following:

1. Dry, non-corrosive locations:
    a. Hubbell; HBL5361 (single), HBL5362 (duplex).
    b. Or Approved Equal.
2. Damp or wet locations:
    a. Hubbell; HBL5361WR (single), HBL5362WR (duplex).
    b. Or Approved Equal.
3. Corrosive locations:
    a. Hubbell; HBL53CM61 (single), HBL53CM62 (duplex).
    b. Or Approved Equal.

2.4 RECEPTACLES FOR CLASSIFIED AREAS

A. General Description

1. Explosion proof, UL Listed for Class 1 Division I and II Groups C & D
2. Rated for 125 V, 20 A
3. Corrosion Resistant with malleable iron mounting box.
4. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle.
5. Factory Sealed so that seal-offs are not required at the receptacle.
6. If receptacles are to have GFCI, this shall be achieved at the branch circuit overcurrent protective device (typically a lighting panel) in an unclassified space.

B. Products: Subject to compliance with requirements, provide the following:

1. Appleton U-Line Contender series.
2. Crouse-Hinds Arktite Series.
3. Or Approved Equal.

2.5 GFCI RECEPTACLES FOR UNCLASSIFIED AREAS

A. General Description:

1. Duplex GFCI Convenience Receptacles, 125 V, 20 A.
2. Straight blade, feed-through type.
3. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
4. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
5. Receptacles shall be tamper and weather resistant.

B. Products: Subject to compliance with requirements, provide the following:

1. Hubbell; GFR5362TR.
2. Or Approved Equal.

2.6 TOGGLE SWITCHES FOR UNCLASSIFIED AREAS

A. General Description:

1. Toggle Switches, 120/277 V, 20A
2. Comply with NEMA WD 1, UL 20, and FS W-S-896.
3. Toggle type, quiet action, specification grade with grounding terminal.
4. Back and side wired, silver alloy contacts.
5. Color: White unless Owner or Engineer specifies otherwise.
6. For corrosive or wet areas, provide a NEMA 4X watertight, dust-tight and corrosion resistant cover.

B. Switches:

1. Products: Subject to compliance with requirements, provide the following:

a. Switches, 120/277 V, 20 A:
   1) Hubbell; HBL1221 (Single Pole); HBL1222 (Double Pole); HBL1223 (Three Way); HBL1224 (Four Way).
   2) Or Approved Equal.

b. Illuminated Switches (illuminated when switch is “off”:
   1) Hubbell; HBL1221IL (Single Pole); HBL1223IL (Three Way).
   2) Or Approved Equal.

c. Key-Operated Switches (with factory supplied key):
   1) Hubbell; HBL1221L
   2) Or Approved Equal.

2.7 TOGGLE SWITCHES FOR CLASSIFIED AREAS

A. General Description:

1. Explosion proof, UL Listed for Class 1 Division I and II Groups C & D
2. Rated for 125 V, 20 A
3. Corrosion Resistant with malleable iron body and cover.
4. Factory Sealed so that seal-offs are not required at the receptacle.
5. Front operated handle with stainless steel shaft.
6. With grounding screw.

B. Products: Subject to compliance with requirements, provide the following:

1. Appleton Contender series.
2. Crouse-Hinds EDS Series.
3. Or Approved Equal.

2.8 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off." Load shall not exceed 80% of dimmer rating.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish except for stainless steel wall plates whose screws shall be stainless steel.
2. Material for Finished Office Spaces: Smooth, high-impact thermoplastic, color to match device color.
3. Material for Finished Spaces: Type 304 stainless steel.
4. Material for Unfinished Spaces: Type 304 stainless steel.
5. Material for Damp and corrosive Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant**,** die-cast aluminum with lockable cover.

C. Weatherproof, While-In-Use Covers: Where receptacles are required to be weatherproof and physically protected while in use or idle or where shown on the drawings, weatherproof, while-in-use covers shall be used in lieu of other covers. The cover shall have the following features:

1. General Description:

   a. Suitable style receptacle plate with a hinged cover.
   b. Cord port(s) capable of allowing an appropriate size electrical cord(s) to pass through when the cover is closed.
   c. Latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant (locking/security) style in areas where security is needed.
   d. Sufficiently deep to allow full closure with plug(s) in use.
   e. UL listed per UL Standard 514C and conform to NEC Article 410.57 paragraphs a and b, Article 110.3 and Article 110.11.
   f. Body materials shall be of a flame resistant, self-extinguishing, UV inhibiting, impact resistant, polycarbonate resin. Materials must meet UL Standard 94 HF1.
   g. Mounting screws shall be stainless steel and of sufficient length to properly secure the device and ensure seal to mounting surface.

2. Products: Subject to compliance with requirements, provide the following:

   a. Cooper; TP74 Series.
   b. Or Approved Equal.

2.10 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless Owner or Engineer specifies otherwise or otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to UPS or Emergency Power System: Red.
3. TVSS Devices: Blue.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Wherever possible, wiring devices shall be recess mounted with switches, receptacles and wall plates flush with the wall or surface.
2. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
3. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
4. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
5. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
6. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
7. Use a torque screwdriver when a torque is recommended or required by manufacturer.

8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
9. Tighten unused terminal screws on the device.
10. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
2. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.
3. Set switches and receptacles plumb and vertical to the floor.
4. Set recess-mounted switches and receptacles flush with face of walls.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. Provide blank plates for empty boxes.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
4. Do not connect dimmers to loads in excess of 80% of the rating of the dimmer.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262923 - VARIABLE-FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. See Section 26 24 19 "Motor-Control Centers" for VFDs installed in motor-control centers.

1.2 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).
B. CPT: Control power transformer.
C. EMI: Electromagnetic interference.
D. IGBT: Insulated-gate bipolar transistor.
E. LAN: Local area network.
F. LED: Light-emitting diode.
G. MCP: Motor-circuit protector.
H. NC: Normally closed.
I. NO: Normally open.
J. OCPD: Overcurrent protective device.
K. PCC: Point of Common Coupling
L. PID: Control action, proportional plus integral plus derivative.
M. PWM: Pulse-width modulated.
N. P&ID: Process & Instrumentation Diagram
O. RFI: Radio-frequency interference.
P. SCADA: Supervisory control and data acquisition.
Q. TDD: Total Demand Distortion
R. THD: Total Harmonic Distortion
S. VFD: Variable-frequency drive.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFDs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFD indicated.

B. System Harmonics Analysis: For each VFD and for the distribution system as a whole.

C. Shop Drawings: For each VFD indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings.
2. Schematic and Connection Wiring Diagrams: For power, signal, communications, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Seismic Qualification Certificates: For VFDs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

C. Product certificates.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

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 NFPA 70.

D. IEEE Compliance: Fabricate and test VFD according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Rockwell Automation, Inc.; Allen-Bradley PowerFlex 700 series drives.
2. Schneider Electric, Inc.; Altivar Process 630 series drives.
3. Eaton SVX/SPX9000 series drives.

B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque and variable torque.

D. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 200 (60 as programmed default) Hz, programmable as voltage proportional to frequency throughout voltage range or with sensorless vector control; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.

4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: Equal to the rating of the gear feeding the drive. If not listed, 65 kA.
7. Ambient Temperature Rating: Not less than 14 deg F (minus 10 deg C) and not exceeding 122 deg F (50 deg C). This is specifically the requirement for the VFD unit itself and not the overall panel assembly. The overall assembly shall meet the requirements of 260000-1.4-A-8 which requires the overall assembly to operate at an ambient temperature of up to 104°F. Electrical equipment not rated for operation at that temperature shall be provided with air conditioning. The majority of the MCC's for the project are located indoors in air-conditioned rooms which satisfies this requirement. VFD assemblies shall have appropriately designed ventilation and or air conditioning so as to protect the internal components and to keep internal panel temperatures below the internal components' rated temperatures.
8. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 158 deg F (70 deg C)
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: VFD system shall be rated for continuous operation at a minimum of 110% of motor load full load amps (FLA) times the motor service factor. Variable torque inverters shall be capable of delivering 110% of continuous rating for a minimum of 60 seconds. Constant torque inverters shall be capable of delivering 150% of continuous rating for a minimum of 60 seconds.
13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
14. Speed Regulation: Plus or minus 0.6 Hz.
15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, VFD isolated from all power circuits.

I. Isolated Control Interface: Allows VFDs to follow remote-control electrical signal over a minimum 100:1 speed range.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.

4. Inverter overcurrent trips.
5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. VFD Fault.
4. All other lights as shown on the design drawings

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

C. Historical Logging Information and Displays:

1. Running log of total power versus time.
2. Total run time.
3. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

    a. Speed Reference: The VFD drive shall be capable of being controlled locally by a speed potentiometer or remotely by a 4- to 20-mA dc signal. The 4- to 20-mA signal shall be galvanically isolated and input resistance shall not exceed 250 ohms.

    b. A minimum of two programmable analog inputs shall be provided and would be typically used for PID process variable and set point. These signals shall be setup to accept a 4- to 20-mA dc signal. The 4- to 20-mA signal shall be galvanically isolated and input resistance shall not exceed 250 ohms.

    c. A minimum of six multifunction programmable digital inputs. The drive shall be expandable to handle additional digital inputs if required. The digital inputs shall be programmable to perform functions including, but not limited to:

        1) VFD Start/Stop Control (2 or 3 wire)
        2) Forward/Reverse/Stop Control
        3) Local/Remote. The VFD shall be programmable so that "Local" control may either be the keypad or by hard-wired start/stop and potentiometer. The VFD shall be programmable so that "Remote" control may either be hard-wired start/stop and 4- to 20mA speed control or via the communications network.
        4) VFD Interlock/Enable. This input when de-energized will not allow the VFD to run the motor under any circumstance.
        5) VFD External Fault. This input will trip the VFD and require a reset before allow the motor to run again.
        6) Preset Frequencies. The VFD shall be programmable to run at pre-programmed frequencies with up to 6 different steps.

2. Output Signal Interface:

a. A minimum of two programmable analog output signals 4- to 20-mA dc, which can be configured for any of the following:

1) Output frequency (Hz).
2) Output current (load).
3) DC-link voltage (V dc).
4) Motor torque (percent).
5) Motor speed (rpm).
6) Set point frequency (Hz).
7) Motor power (kW)

b. A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following (the drive shall be expandable to handle additional digital outputs if required):

1) Motor running.
2) VFD ready.
3) Set point speed reached.
4) Fault and warning indication (overtemperature or overcurrent).
5) PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

G. SCADA Interface: Factory-installed hardware and software to enable the SCADA to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: Ethernet
2. SCADA Protocols for Network Communications: Ethernet/IP protocol accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: All new power distribution systems supplied shall be required to meet the requirements of IEEE 519-1992. Specifically, the system shall adhere to the TDD requirements of Table 10-3 of IEEE 519-1992. If the power distribution system is equipped with an Active Harmonic System, each VFD shall be equipped with a line reactor whose impedance is as recommended by the Active Harmonic System manufacturer (typically 3%). If no Active Harmonic System is part of the power distribution system, the following rules as a minimum shall define the input line conditioning for each VFD (unless further conditioning is required to meet the IEEE 519-1992 limits). With the Engineer’s approval, the contractor may decide to supply an Active Harmonic System even if not shown on the drawings, with corresponding reactors and chokes (this would typically occur if it is more cost effective to meet IEEE 519 with a single system then multiple harmonic filters).

1. All VFD's sized for motors 50HP or larger shall be equipped with DC-link chokes.
2. All VFD's sized for motors 40HP and less shall be equipped with 5% line reactors unless specifically called out as otherwise on the drawings.
3. All VFD's sized for 50HP to 200HP motors shall be equipped with passive harmonic filters with DC Link Chokes.
4. All VFD's greater than 200HP shall have be setup to have less than 5% THD for both voltage and current. This would typically require that the drive is setup with an 18-pulse front end or with an active harmonic filter. The VFD assembly shall accept a single 3-phase input and shall contain all of the harmonic mitigation equipment as part of the assembly.

B. EMI/RFI Filtering: VFD's shall be CE marked and certify compliance with IEC 61800-3 for Category C2.

2.4 LOAD CONDITIONING

A. Load Conditioning: For VFD driven loads with conductor lengths between 200 and 1,000 feet, output dV/dt filters shall be provided as part of the VFD assembly. It is strongly recommended that VFD motor leads not be longer than 500 feet and alternative VFD locations should be considered. If absolutely necessary, loads with conductor lengths greater than 1,000 feet shall have output sine wave filters shall be provided as part of the VFD assembly. Voltage drop considerations shall be taken into account when selecting the motor's nameplate voltage.

2.5 LINE AND LOAD CONDITIONING EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MTE Corporation.
2. Transcoil International (TCI).
3. Or approved equal.

B. Line Reactors: Reactors shall be part of the VFD assembly. They shall be sized based upon the VFD input power requirements. They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The reactor shall meet the following criteria:

1. The reactor shall be UL 508 listed.
2. Continuous current rating: 100% RMS.
3. Intermittent current ratings: 150% for 60 seconds; 200% for 10 seconds.
4. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
5. All wiring shall be copper.

C. Passive Harmonic Filters: Filters shall be part of the VFD assembly. They shall be sized based upon the VFD input power requirements. They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.

2. The filter shall filter harmonics generated by the nonlinear VFD to satisfy the requirements of IEEE 519-1992 for individual and total harmonic voltage and current distortion at the input terminals of the filter.
3. The TDD of the current at the input terminals of the filter shall not exceed the limits defined in Table 10-3 of IEEE 519-1992.
4. Full load efficiency: 97% or greater
5. The filter shall not resonate with the power distribution system nor attract harmonics from other sources.
6. The harmonic filter shall be a passive series connected low pass filter consisting of an inductor capacitor network. Active electronic components shall not be used.
7. The harmonic filter shall be equipped with a contactor that will connect the capacitor(s) only when the motor is running, avoiding nuisance VFD over-voltage tripping.
8. All wiring shall be copper.

D. dV/dt Filters: Filters shall be part of the VFD assembly. They shall be sized based upon motor horsepower and required full-load current (including service factor). They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.
2. Maximum peak motor terminal voltage with 500 feet of cable: 15% of bus voltage.
3. Maximum dV/dt: 200 Volts per microsecond.
4. The dV/dt Filter shall reduce common mode voltages by a minimum of 40%.
5. Continuous current rating: 100% RMS.
6. Intermittent current ratings: 150% for 60 seconds; 200% for 10 seconds.
7. Allowed inverter switching frequencies: 1kHz to 8 kHz.
8. Nominal inverter operating frequency: 60Hz; Minimum – 6 Hz; Maximum with de-rating: 120Hz.
9. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
10. Insertion loss: 3% of rated voltage maximum.
11. All wiring shall be copper.

E. Sine Wave Filters: Filters shall be part of the VFD assembly. They shall be sized based upon motor horsepower and required full-load current (including service factor). They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.
2. Harmonic Voltage Distortion: 10% maximum
3. Continuous current rating: 100% RMS.
4. Intermittent current rating: 150% for 60 seconds.
5. Allowed inverter switching frequencies: 2kHz to 8 kHz.
6. Nominal inverter operating frequency: 60Hz; Minimum – 0 Hz; Maximum with de-rating: 90Hz.
7. The Sine Wave Filter shall reduce common mode voltages by a minimum of 40%.
8. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
9. Insertion loss: 6% of rated voltage maximum.
10. All wiring shall be copper.

2.6 BYPASS SYSTEMS

A. Provide Bypass Systems only if indicated on the drawings.

B. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

E. Bypass Contactor Configuration: Full-voltage (across-the-line) or reduced voltage soft-starter as shown on the drawings.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

   a. CPT Spare Capacity: 100 VA.

6. Overload Relays: NEMA ICS 2.

2.7 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry, Clean and Non-corrosive Indoor Locations: Type 1.
2. Outdoor or Corrosive Locations: Type 4X, stainless steel.
3. Wash-Down Areas: Type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.8 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.

    a. Push Buttons: Maintained and/or momentary as required.
    b. Pilot Lights: LED types; colors as shown on P&ID's; push to test.
    c. Selector Switches: Rotary type.

B. Bypass contactor auxiliary contact(s) as required.

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Analog Meters:

1. Elapsed time meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4, 4X, and 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4, 4X, 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, maintaining enclosure NEMA rating; UL 508 component recognized: Supply fan, with non-corrosive intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

I. Air Conditioning System: For NEMA 250, maintaining enclosure NEMA rating; UL 508 component recognized; sized to maintain internal temperatures at or below 100°F.

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to its specified motor.
2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFD.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.2 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:

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

D. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

9. Perform voltage and current harmonic test with each VFD running at minimum and maximum speed. Submit test results for each VFD. Testing shall be witnessed by the Owner and the Engineer.

E. VFDs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs. A minimum of 4 hours of training shall be provided. The training shall cover VFD theory of operation, features and functions available, normal operation, troubleshooting, and routine maintenance. The Contractor shall submit a syllabus for the training session for approval, within 3 weeks of conducting the class. Provide each attendee with a class syllabus detailing each topic to be discussed.

3.7 SPARE PARTS

A. The following spare parts shall be supplied with each type, or frame size, of VFD:
1. 3 sets of all replaceable fuses
2. 3 spare air conditioner or fan filters

END OF 262923

SECTION 265000 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.

1.2 SCOPE OF WORK

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting fixtures.

1.3 QUALITY ASSURANCE

A. Reference Standards:

1. National Electrical Code (NEC)
2. UL Standard #57, Electric Lighting Fixtures
3. UL Standard #844, Electric Lighting Fixtures for Use in Hazardous Location
4. UL Standard #1570, Fluorescent Lighting Fixtures
5. UL Standard #1571, Incandescent Lighting Fixtures
6. UL Standard #1572, High Intensity Discharge Lighting Fixtures
7. Illuminating Engineering Society (IES)
8. All applicable local lighting ordinances

B. Miscellaneous:

1. Lamps are identified for each luminaire in the Lighting Fixture Schedule on the Plans.
2. Lighting fixtures and electrical components:
   a. UL labeled, complete with lamps.
   b. Rated for area classification as indicated.
      1) All lighting in classified areas are to be of the T3 temperature class unless otherwise indicated, refer to Table 500.8(B) of the NEC.
   c. Lighting shall meet OSHA requirements.
3. On the Plans, the location of lighting fixtures is intended to be used as a guide.
   a. Field conditions may affect actual locations.
   b. Coordinate with other trades to avoid conflicts in mounting of fixtures and other equipment.
4. The quality standard is established by the fixture listed in the Lighting Fixture Schedule.
   a. This quality standard includes, but is not necessarily limited to construction features, materials of construction, finish, and photometrics.

1.4 SUBMITTALS

A. The following shall be submitted to the Engineer for review:

1. Acknowledgment that products submitted meet requirements of standards referenced.
2. Manufacturer’s technical information on products to be used including photometric performance curves for the fixture and ballast data.
3. Acknowledgment that products submitted are UL listed.
4. When general data sheets constitute part of the submittal, identify the products to be used on this project.
5. Manufacturer’s installation instructions.
6. Identification of fixtures by Lighting Fixture Schedule.
7. UL nameplate data (Voltage, wattage, etc.).
8. Finishes, colors, and mounting type.
9. Pole, fixture, and accessories.
10. Pole wind loading.

B. Contractor shall submit shop drawings, manufacturer's data sheets, and a complete wiring diagram detailing all connections to the electrical system in accordance with Section 013300 “Contractor Submittals” and Section 260000 “General Electrical Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Lamps shall be manufactured by:

1. General Electric
2. North American/Phillips
3. Sylvania
4. Approved equal.

B. Lighting fixtures shall be provided as indicated on the Lighting Fixture Schedule on the Plans.

C. Lighting ballasts shall be manufactured by:

1. General Electric
2. Advance
3. Jefferson
4. Universal
5. Bodine
6. Lithonia
7. Approved equal

D. Light poles shall be as indicated on the Plans. Include base template, anchor bolts, cadmium-plated hardware and pole grounding lug, hand-hole, anchor base and bolt covers. Pole foundations shall be as indicated on the Plans.

2.2 MATERIALS

A. General:

1. Lamps:
   a. See lighting fixture schedule on Plans for wattage, voltage and number required.
2. All Fixtures:
   a. There shall be no live parts normally exposed to contact.
   b. When intended for use in wet area:
      1) Mark fixtures “suitable for wet locations.”
   c. When intended for use in damp areas:
      1) Mark fixtures “suitable for damp locations” or “suitable for wet locations.”
   d. In wet or damp area, install fixtures so that water cannot enter or accumulate in the wiring compartment, lamp-holder, or other electrical parts.
   e. Gasket seals: Urethane foam
   f. Diffusers: UV stabilized acrylic plastic
3. Underground wiring:
   a. Provide all wiring runs with separate green grounding conductor.
   b. Ground all pole bases.
4. Pole wiring from base to ballast:
   a. No. 12 type XHHW.
   b. Each phase shall be protected by a 30A, 600V, type Tron waterproof fuse-holder, Bussman “Limitron” type fuse, size rating 3-times load current.

B. Incandescent Lamps:

1. No incandescent lamps shall be allowed

C. Fluorescent Lamps:

1. Rapid start
2. Cool white (F32T8/41K-85CRI and F96T12/41K-70CRI/HO/ES)
3. Energy efficient or standard as noted on the lighting fixture schedule.

D. High-Pressure Sodium Lamps:

1. Bulb finish: Clear
2. Any burning position

E. Metal Halide Lamps:

1. Bulb finish: Clear
2. Any burning position

F. LED:

1. Lifespan: 50,000 hour
2. Minimum CRI: 85
3. Minimum Color Temperature: 4000K

G. Furnish a minimum of 2 lamps, or ten percent spare lamps of each type and wattage, whichever is greater.

2.3 FIXTURES

A. Fluorescent Lighting Fixtures:

1. Ballast:
   a. Rapid start, high power factor type
   b. CBM/ETL certified
   c. Sound rating A
   d. Two internal automatic-resetting thermal switch devices for coil and capacitor
2. Internal wiring: AWM, TFN or THHN
3. Channel and end plates: 22 GA steel
4. Steel door frame and socket track: 20 GA steel
5. Channel cover: 24 GA steel
6. Emergency ballast:
   a. Integral rechargeable nickel-cadmium battery, battery charger, and automatic transfer circuitry.
   b. Charging indicator light.
   c. Test Switch.
   d. Provide a minimum of 900 lumen output for 90 minutes upon loss of normal power.
   e. Mounted integral to the fixture.
   f. UL 924 listed.
7. Provide fixtures with emergency ballasts with permanent caution labels warning that the fixture is fed from an un-switched source
   a. Provide emergency ballast also with a similar caution label.

B. HID Lighting Fixtures:

1. Ballasts for high pressure sodium lighting fixtures:
   a. Type: Regulating
   b. Ballast design center variance: Maximum 5 percent from rated lamp wattage.
   c. Lamp wattage regulation spread at the lamp voltage: Maximum 10 percent for +/-10 percent line voltage variation.
   d. Ballast primary current during starting not to exceed normal operating current.
   e. Lamp current crest factor: Maximum 1.8 for +/-10 percent line voltage variation at any lamp voltage, from nominal through life.
   f. Power factor shall not drop below 90 percent for +/-10 percent line voltage variations at any lamp voltage, from nominal through life.
   g. Capacitor variance: Tolerance of +/-6 percent which will not cause more than a +/-8 percent variation in regulation throughout rated lamp life for nominal line voltage.
   h. Capable of operation with an open circuit condition for a maximum of 6 months without significant loss of ballast or starting circuitry life.
2. Ballasts for metal halide/mercury vapor lighting fixtures:
   a. Type: Auto-regulator
   b. Voltage input range: +/-10 percent
   c. Lamp regulation spread: 20 percent maximum
   d. Power factor: 90 to 90 percent
   e. Input voltage dip (4sec.): 40 to 50 percent

f. Crest factor of lamp current: 1.6 to 2.0

3. Ballasts for exterior HID lamps:
   a. UL approved
   b. High power factor designed for -20 °F temperature starting
4. Fixtures for non-hazardous locations:
   a. Type: Industrial low bay
   b. Ballast housing: Die-cast
   c. Filter: Activated charcoal
   d. Refractor: UV stabilized molded acrylic

C. LED Lighting Fixtures:

1. Heavy duty two piece, die cast aluminum housing.
2. Silicon gasketing for moisture protection
3. Polyester powder finish for impact, corrosion and UV resistance
4. Cast-in aluminum hinges for tool-less lens removal.
5. Thermal and shock resistant clear borosilicate glass refractor.
6. Field replaceable LED light engine and driver.

2.4 EMERGENCY FLUORESCENT POWER UNIT

1. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
   a. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
   a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.

2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.6 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

2.7 MISCELLANEOUS ELECTRIC DEVICES

A. PHOTOELECTRIC CONTROL UNITS shall meet the following requirements:

1. Cadmium sulfide photocell
2. Aluminum weatherproof enclosure
3. 30 amp rated contacts
4. 120-volt AC power
5. The Photoelectric control unit shall be Tork Model 2100, or equal.

B. MOTION SENSORS shall meet the following requirements:

1. 110° field of view, 60-foot range
2. Adjustable time setting from 15 seconds to 15 minutes
3. Operating temperature of -20 to + 130 °F.

4. Complete outdoor, weather proof sensor with complete mounting hardware
5. UL listed
6. The motion sensor(s) shall be manufactured by Leviton Model 50500-H or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Comply with NFPA 70 for minimum fixture supports.

C. Install lamps in all luminaires.

D. Replace all failed fluorescent, incandescent, metal halide, mercury vapor, high pressure sodium and LED lamps with new lamps prior to final acceptance by Owner.

E. Surface and flush mounted fixtures shall be solidly connected to a junction box. Suspended fixtures shall be hung utilizing pendant mounting or stainless steel chains and hooks. Each suspended fixture, shall be electrically connected by a length of Type SO flexible cord. 3 conductor No. 14 AWG, minimum, with a twist-lock receptacle mounted in an individual junction box. Plugs and receptacles shall be as manufactured by Hubbell, General Electric Company, or equal.

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

G. Install with approved mounting hardware following manufacturer's recommendations.

H. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

1. Do not support fixture from conduit system.
2. Do not support fixture from outlet boxes.

I. Pole mounted fixtures shall be mounted on steel or aluminum poles as indicated on the Plans. All metal poles shall be bonded to the facility ground system. Poles shall have adequate handholes and weatherproof receptacles where indicated.

J. All anchor bolts and nuts shall be stainless steel. Contractor shall paint all steel poles with aluminum paint or other color in accordance with these Contract Documents.

K. Fixture mounting heights and locations indicated on the Plans are approximate and are subject to revision in the field where necessary to avoid conflicts and obstructions.

3.2 ADJUSTING AND CLEANING

A. Wipe all lighting fixture reflectors, lenses, lamps, and trims clean after installation and prior to acceptance of Project by Owner.

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION 265000

ECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Clearing and grubbing.
   2. Stripping and stockpiling topsoil.

1.2 MATERIAL OWNERSHIP

A. Except materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. Prior to clearing or excavation operation, Contractor shall meet with the Owner to discuss any issues or potential problems that may arise from such activity.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Pothole for existing utilities in project areas.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited outside the limits of construction:

   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving"

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with Owner/utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner/Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's/Engineer's written permission.

C. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section 024100 "Demolition, Salvage and Reconstruction".

3.4 CLEARING AND GRUBBING

A. Any trash, construction debris, concrete slabs, old pavement, landfill, and buried obstructions such as old foundations shall be traced to the limits and removed.

B. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Trees to be removed shall be marked and approved by the Owner prior to their removal.

2. Root balls shall be removed completely.

3. Remove obstructions, and debris to a minimum depth of 18 inches below exposed subgrade. Additional removal may be required to accommodate specific pipelines, structures, or other improvements.

C. Fill depressions caused by clearing and grubbing operations with structural fill material unless further excavation or earthwork is indicated.

1. Any excavations resulting from clearing and grubbing should be dish-shaped to the lowest depth of disturbance and backfilled with structural fill.

2. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Strip topsoil to depth indicated in section 319000 "Geotechnical Report" in a manner to prevent intermingling with underlying subsoil or other waste materials. Excess trash, debris, concrete and buried obstructions shall be disposed of as indicated in the drawings and at the Engineer's discretion.

B. Organic stripping shall be hauled off site and shall not be used as fill.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil and dispose offsite. Remove obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 311100 – FINISH GRADING AND LANDSCAPING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, services and equipment indicated on the Drawings and/or herein specified to complete all Finish Grading Work.

B. Finish grading shall consist of the final grading and shaping of all areas, except those areas under pavements, slabs and structures, to conform to lines, elevations and shapes as indicated on the Drawings.

1.2 DEFINITIONS

A. Subgrade: Subgrade shall mean surfaces upon which additional specified materials are to be placed, prepared or constructed.

B. Rough Grading: Rough grading shall mean the act that includes the spreading or placement of specified materials to the tolerances defined as final rough grade.

C. Final Rough Grade: Final rough grade shall mean the establishment of grades to a .15 foot plus or minus tolerance of grades required to accomplish the work described in other sections of the specifications on the drawings (i.e. landscape work, finish grading, concrete work, asphalt work, etc.)

D. Finish Grading: Finish grading shall mean the act that includes the spreading or placement of specified materials to establish the tolerances defined as final finish grade.

E. Final Finish Grade: Final finish grade shall mean the establishment of grades to a plus or minus tolerance of final grades as indicated on drawings. Tolerances are specified in applicable sections of the specifications (i.e. concrete, asphalt, finish grading, etc.).

1.3 RELATED WORK

A. Division One - General Requirements.

1.4 SUBMITTALS

A. Topsoil shall be subject to inspection and approval at the source of supply or upon delivery.

1.5 QUALITY ASSURANCE

A. All spot elevations to be staked for verification and approval by the Engineer.

B. Finish grade tolerance shall be within plus or minus 0.15 foot of final grades indicated on drawings.

C. Finished grades shall conform to shapes, spot elevations and contours, as indicated on drawings, with uniform levels or slopes between finished elevations or between finished elevations and existing elevations.

PART 2 - PRODUCTS

2.1 IMPORTED FILL MATERIALS

A. ¾” crushed rock, thickness per plans. Apply over prepared subgrade. Subgrade shall be prepared as follows:
   1. Prior to placement of any fill material, the surface 12 inches of soil should be removed, and the exposed surface should be uniformly moisture conditioned to a depth of 8 inches by discing and wetting to +/-2% of optimum moisture and re-compacted to at least 90% of ASTM D1557 maximum density.

2.2 GENERAL

A. Conduct work in an orderly manner and so as to not create a nuisance. Dirt shall not be permitted to accumulate on streets or sidewalks not to be washed into storm sewers.

B. Finished grades shall be established using materials as specified.

C. Mass Grading – Refer to Section 312000.

D. Finish grade tolerance shall be within plus or minus .15 foot of final grades indicated on drawings.

E. Finished grades shall conform to shapes, spot elevations and contours, as indicated on drawings, with uniform levels or slopes between finished elevations and existing elevations.

F. Finished grades shall be established to provide after settling, adequate drainage in a uniform way so no water pockets or ridges will be created.

2.3 FINISH GRADING

A. Fine grade all areas to a smooth, and uniform surface.

END OF SECTION 311100

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf, and grasses and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks, pavements.
5. Subbase course and base course for asphalt paving.
6. Excavating and backfilling for utility trenches.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 QUALITY ASSURANCE

A. Contractor to notify Engineer of excavation plans a minimum of 48 hours in advance.

1.4 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

C. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

E. Structural/Engineered Fill:

1. On-site soils may be used as structural/engineered fill provided that the following criteria is met:

a. No particles larger than 3 inches in largest dimension (rocks larger than one inch shall not be placed within the upper 12 inches of subgrade soils)
b. Free of all organic matter, debris or other deleterious material.
c. Expansion index of 40 or less.
d. Sand equivalent greater than 15 (greater than 30 for pipe bedding)
e. Contain less than 30 percent by weight retained in ¾-inch sieve.
f. Contain less than 40 percent fines (passing #200 sieve)

2. Imported materials, if required, shall meet the above criteria prior to being used as structural/engineered compacted fill. Any imported fill material shall be tested and approved by City's geotechnical representative prior to delivery to the site.

F. Pipe Bedding Course:
1. Pipe bedding requirements for Recycle Water Line outside the Lift Station site shall follow the BCVWD standards.
2. Pipe bedding requirements within the Lift Station Site shall follow the City of Beaumont standards.
3. If additional recommendations beyond the Standards above are needed, the following specification can be used:
a. Naturally or artificially grade mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve. Sand equivalent of 30 or more.

G. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve. The gradation shall have the following gradation requirements:

Sieve Size	Percentage Passing
1-1/2-inch	100
3/4-inch	90-100
3/8-inch	40-100
No. 4	5-40
No. 8	0-5

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavations shall include the removal of all materials of whatever nature encountered including removal or relocation of all obstructions that would interfere with the proper execution of the Work. The removal of said materials shall conform to the lines and grades shown on the plans or ordered by the Engineer. The Contractor shall furnish, place and maintain all supports and shoring that may be required for safety of excavations and protection of adjacent structures and all pumping, ditching or other measures necessary for the removal or exclusion of water, including taking care of storm water, groundwater and wastewater reaching the site of the Work from any source so as to prevent damage to the Work or adjoining property. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Excavations and over-excavations beneath structures shall be as required by the Geotechnical Report included in Section 319000. Over-excavations ordered by the Engineer that are not shown or specified and the resulting backfill will be paid for under a separate unit price bid item if such bid item has been established, otherwise payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed the exposed surface shall be scarified to a depth of 6-inches, brought to optimum moisture content as defined in section 319000 (Geotechnical Report) and recompacted to obtain a minimum ninety percent (90%) of laboratory maximum dry density.

C. Excavation under roadways and areas to be paved shall extend to the bottom of the aggregate base. After the required excavation has been completed the exposed surface shall be scarified brought to optimum moisture content and rolled with heavy compaction equipment to obtain ninety-five percent (95%) of maximum density.

D. The subgrade area beneath embankments shall be excavated to remove the top 8-inches of native or topsoil material. Where the subgrade is sloped the excavation shall be benched.

E. The Contractor shall keep separate and stockpile from required excavations all topsoil consisting of the top 8-inches of native material. The Contractor shall place and grade this topsoil material as the top 6-inches on areas requiring landscaping, if applicable, to the extent it remains available.

F. The Contractor shall notify the Engineer of the completion of any structural excavation and shall allow the Engineer at least 24-hours review period before the exposed foundation is scarified and compacted or is covered with any structural backfill materials.

G. The Contractor shall remove and dispose of all excess excavated material at a site selected by the Contractor and reviewed by the Engineer.

H. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

I. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Unless otherwise shown or ordered, excavation for pipelines and utilities shall be open-cut trenches. The bottom of the trench shall have a minimum width equal to the outside diameter of the pipe plus 24-inches. Trenches for pipelines smaller than 8-inches shall be excavated uniformly to the grade of the bottom of the pipe. Trenches for pipelines 8 inches and larger, unless otherwise ordered by the Engineer, shall be excavated uniformly to the grade 6-inches below the grade of the outside bottom of the pipe. The over-excavation shall be replaced with material as indicated in the Geotechnical Report (Section 319000). The pipe bedding shall be compacted by mechanical means suitable to the Engineer to eighty-five percent (85%) of relative density. The trench bottom shall be uniformly graded so that each pipe section when first laid will be continually in contact with the bedding along the entire length of the pipe. Where granular backfill under footings encases an underdrain piping system or has a thickness of 18-inches or greater or where shown on the Drawings, a layer of soil stabilization fabric shall be placed under the first horizontal layer of granular backfill. Soil stabilizer fabric shall be Mirafi 500, Contech C200, or equal. The sloping or vertical side slopes shall receive a layer of Mirafi 140 NL, Contech C-45NW, or equal.

B. The maximum amount of open trench permitted in any one location shall be the length necessary to accommodate the amount of pipe installed and backfilled in a single day. The Contractor shall make every reasonable effort to backfill all trenches at the end of each day. When this is not possible, barricades with warning lights meeting OSHA requirements shall be provided, set and maintained.

C. All pipeline and utility trench excavations shall be kept reasonably free from excess water during excavation, fine grading, pipe laying, and backfilling operations. Ground water shall be lowered to the extent necessary to keep the trench free from water and the trench bottom stable when the work within the trench is in progress. The Contractor shall provide and maintain at all times during construction ample means and equipment with which to properly and promptly remove and dispose of all water entering the excavation or other parts of the Work whether the water be surface water or underground water. The Contractor shall dispose of the water from the Work site in a suitable manner without damage to adjacent property.

D. When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be over-excavated beyond the depth shown or specified. Such over-excavation shall be to the depth ordered. The trench shall then be backfilled to the grade required. When the over excavation ordered by the Engineer is 4-inches or greater below the limits shown, additional payment will be made to the Contractor for that portion of the Work which is located below said 4-inch distance. Said additional payment will be made under separate unit price bid items for over-excavation and bedding if such bid items have been established, otherwise payment will be made in accordance with a negotiated price.

E. The Contractor shall remove and dispose of all excess excavated material at a site selected by the Contractor and reviewed by the Engineer.

F. Excavate trenches to indicated gradients, lines, depths, and elevations.

G. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Fill of unauthorized excavations shall be at the Contractor's expense. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 PIPE AND UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of water, mud, frost, snow, or ice.

B. Except for drain rock materials being placed in over-excavated areas of the trench for dewatering purposes, backfill shall be placed after all water is removed from the excavation.

C. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

D. Trenches under Footings: Any piping which passes below a footing within 6 feet (measured from the bottom of the footing to the top of the pipe), shall be encased in concrete as detailed in the drawings.

E. Place and compact initial backfill of as required in the Geotechnical Report (Section 319000).

1. Backfill material shall not be dropped directly on the pipe or utility conduit.

2. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill as required in the Geotechnical Report (Section 319000) to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

H. Pipe-zone and utility trench backfill material shall be spread and compacted in layers not to exceed 6-inches in thickness. Compaction shall be achieved using mechanical equipment. Flooding, ponding or jetting shall not be used for compaction unless otherwise approved by the Engineer. Pipe zone backfill material shall be manually spread around the pipe so, when compacted, the pipe zone backfill will provide uniform bearing and side support. Piping shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfill operations. Trench zone backfill material shall be uniformly spread and mechanically compacted in layers not to exceed 12-inches in thickness. Moisture content shall be uniformly adjusted by wetting or drying as necessary.

I. Pipe zone including bedding compaction requirements shall be as indicated in the Geotechnical Report (Section 319000)

J. Aggregate base course materials shall be placed and compacted to not less than ninety-five percent (95%) of maximum density.

3.9 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations using satisfactory native material, or imported as required in the Geotechnical Report.

3.10 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction. Optimum moisture content shall be as indicated in the Geotechnical Report (Section 319000).

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Placement and compaction of backfill and fill material shall be in accordance with recommendations provided in the Geotechnical Report (Section 319000).

C. Backfill shall not be dropped directly on or against any structure. Backfill shall not be placed around or upon any structure until the concrete has attained the required strength to support the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested for leaks and the structures are full of water while the backfill is being placed.

D. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations or may cause damage to the structure.

3.12 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.13 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Shape subbase course and base course to required crown elevations and cross-slope grades.
2. Place subbase course and base course in accordance with recommendations of the Geotechnical Report (Section 319000)
3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry density according to ASTM D1557.

3.14 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Refer to General Conditions and Summary of Work to determine who will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property at the Contractor’s expense.

3.18 DEWATERING

A. Prevent surface water and subsurface or ground water from flowing into trenches and excavations and from flooding project site and surrounding area.

1. The Contractor shall investigate site and submit a dewatering plan to the engineer for review

2. The existing drain system may be used for discharging ground water.

3. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well point, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

4. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

END OF SECTION 312000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes construction dewatering.

1.3 PERFORMANCE REQUIREMENTS

A. The Contractor shall provide all labor, materials, and equipment necessary to dewater site excavations, in accordance with the requirement of the Contract Documents.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system if no longer needed.

C. To complete this Work, the Contractor shall secure any required Permits for Construction Dewatering and Hydrostatic Testing prior to commencing any dewatering work.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is included elsewhere in section 319000.

C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain free water level below bottom of excavation during construction.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

    1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 312319

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

1.2 RELATED SECTIONS

A. Section 319000 – Geotechnical Report

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

B. All excavations shall be adequately shored, braced, and sheeted to prevent earth movement or settlement. Existing structures, piping, duct bank/conduits, and other improvements that are to remain shall be fully protected from damage.

C. Proper shoring, sloping, sheeting, and bracing is required for all excavation where five feet in depth or more is required. A CALOSHA permit shall be obtained for trenches five feet or great in depth. A copy of this permit shall be supplied to the Owner with an additional copy kept at the job site at all times.

D. Contractor shall submit shoring, underpinning, and earth retention calculations and shop drawings to the District and Engineer prior to commencing the work that requires said retention. All calculations and drawings shall be prepared under the supervision of and signed and stamped by a civil engineer licensed in California.

E. Contractor shall provide positive protection (mat/sheet coverings) for all excavation slopes to protect slopes from instability and deterioration. This includes slopes on soil piles used for pre-loading and surcharging of areas.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Contractor shall coordinate all elements of the soil retention system with all surrounding utilities, structures, buildings, pipelines, and other improvements that are to remain and need to be protected. Shoring shall account for surcharge and other loading from adjacent footings and structures that are near excavation and require protection.

B. Prior to excavation or installation activities for elements of soil retaining systems, Contractor shall establish benchmarks around the perimeter of the area to be excavated. These marks shall be surveyed for vertical and horizontal movement at frequent intervals during actual excavation and construction work. Results of these surveys shall be submitted to Owner and Engineer for review.

C. A material testing laboratory (furnished by the District) shall review and monitor the excavation and soil retention systems. The Contractor shall provide, install and survey the vertical and horizontal movements of the top of the soil retention system as well as benchmarks placed adjacent to and for the retaining system. Results of these surveys will be reviewed by District and District's consultants.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Engineer.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.

END OF SECTION 315000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 319000 – GEOTECHNICAL REPORT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the Geotechnical Report prepared for this project (see attached 61-page report and 6-page addendum).

THIS PAGE WAS INTENTIONALLY LEFT BLANK

Converse Consultants
Geotechnical Engineering
Environmental & Groundwater Science
Inspection & Testing Services

GEOTECHNICAL INVESTIGATION REPORT

MESA LIFT STATION UPGRADES

Southeast Corner of the Intersection of Potrero Boulevard and Castello Lane
City of Beaumont, Riverside County, California

CONVERSE PROJECT NO. 21-81-289-01

Prepared For:

ALBERT A. WEBB ASSOCIATES
3788 McCray Street
Riverside, CA 92506

Presented By:

CONVERSE CONSULTANTS
2021 Rancho Drive, Suite 1
Redlands, CA 92373
909-796-0544

June 23, 2022

Converse Consultants
Geotechnical Engineering, Environmental & Groundwater Science, Inspection & Testing Services

June 23, 2022

Mr. Bradley Sackett, PE
Senior Engineer
Albert A. Webb Associates
3788 McCray Street
Riverside, CA 92506

Subject: **GEOTECHNICAL INVESTIGATION REPORT**
Mesa Lift Station Upgrades
Southeast Corner of the Intersection of Potrero Boulevard and Castello Lane
City of Beaumont, Riverside County, California
Converse Project No. 21-81-289-01

Dear Mr. Sackett:

Converse Consultants (Converse) is pleased to submit this geotechnical investigation report to assist with the design and construction of the Mesa Lift Station upgrades located at the southeast corner of the intersection of Potrero Boulevard and Castello Lane in the City of Beaumont, Riverside County, California. This report was prepared in accordance with our proposal dated December 13, 2021, and your Subconsultant Agreement dated March 8, 2022.

Based upon our field investigation, laboratory data, and analyses, the proposed project is considered feasible from a geotechnical standpoint, provided the recommendations presented in this report are incorporated into the design and construction of the project.

We appreciate the opportunity to be of service to Albert A. Webb Associates. Should you have any questions, please do not hesitate to contact us at 909-796-0544.

CONVERSE CONSULTANTS

Hashmi S. E. Quazi, PhD, PE, GE
Principal Engineer

Dist.: 4/Addressee
HSQ/MS/kvg

PROFESSIONAL CERTIFICATION

This report has been prepared by the following professionals whose seals and signatures appear herein.

The findings, recommendations, specifications and professional opinions contained in this report were prepared in accordance with the generally accepted professional engineering and engineering geologic principle and practice in this area of Southern California. We make no other warranty, either expressed or implied.

Mahmoud Suliman, MS
Staff Engineer

Robert L. Gregorek II, PG, CEG
Senior Geologist

Hashmi S. E. Quazi, PhD, PE, GE
Principal Engineer

TABLE OF CONTENTS

FIGURES

Following Page No.

TABLES

Page No.

APPENDICES

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation performed for the Mesa Lift Station Upgrades located at the southeast corner of the intersection of Potrero Boulevard and Castello Lane in the City of Beaumont, Riverside County, California. The project location is shown in Figure No. 1, *Approximate Project Location Map*.

The purposes of this investigation were to determine the nature and engineering properties of the subsurface soils, and to provide design and construction recommendations for the project.

This report is prepared for the project described herein and is intended for use solely by Albert A. Webb Associates and their authorized agents for design purposes. It should not be used as a bidding document but may be made available to the potential contractors for information on factual data only. For bidding purposes, the contractors should be responsible for making their own interpretation of the data contained in this report.

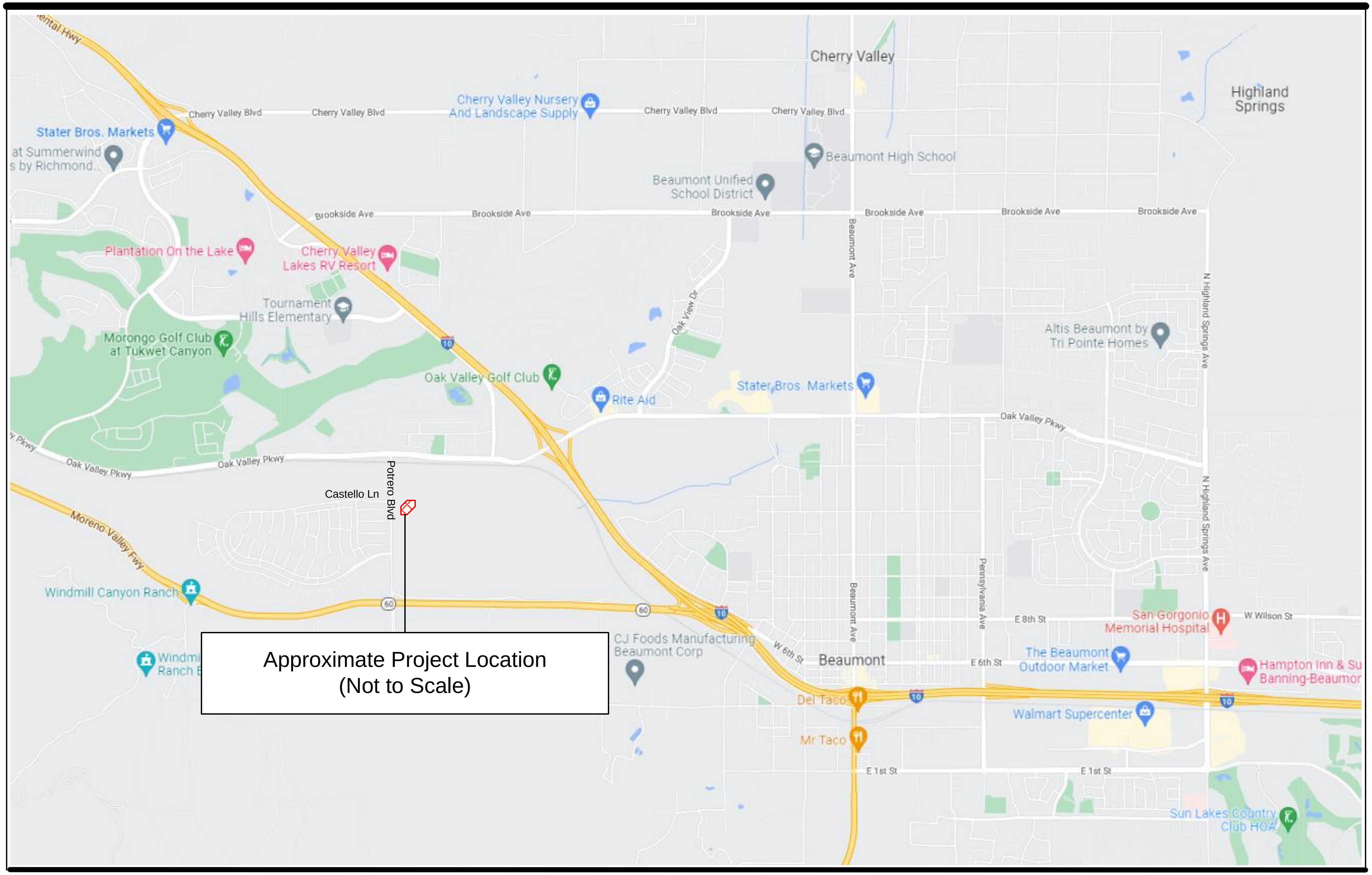
2.0 PROJECT DESCRIPTION

The project will consist of the following.

- Construction of a new 250,000-gallon emergency storage. The approximate dimensions of the emergency storage are 70 to 90 feet wide and 90 feet long, with a maximum depth of 10 feet below surface to allow gravity flow back into the wet well when pumping capacity is restored. The final configuration of the emergency storage was not confirmed at the time of issuing this report.
- New pump configuration (4 pumps) to replace the existing pump configuration for increased pumping capacity.
- new VFDs, flow meters, driveway paving, and site improvements

3.0 SITE DESCRIPTION

The Mesa Lift Station site is located at the southeast corner of the intersection of Potrero Boulevard and Castello Lane in the City of Beaumont, Riverside County, California. The station is bounded on the north by Little San Gorgonio Creek, the east and south by an uprising slope and from the west by Potrero Boulevard. The site is surrounded with standard masonry wall on all sides with a gated entrance from the south. The site is covered with around 3 inches of gravel layer. The site has existing pump, odor control and electrical equipment. Photograph No. 1 depict the present site conditions.



Project: Mesa Lift Station Upgrades

Location: Southeast Corner of the intersection of Potrero Blvd. & Castello Ln.
City of Beaumont, Riverside County, California

For: Albert Webb Associates

Approximate Project Location Map

Project No.
20-81-289-01

Converse Consultants

Figure No.
1

Photograph No. 1: Present site conditions, facing southeast

4.0 SCOPE OF WORK

The scope of this investigation included project set-up, subsurface exploration, laboratory testing, engineering analysis, and preparation of this report, as described in the following sections.

4.1 Document Review

We reviewed geologic maps, aerial photographs, groundwater data, and other information pertaining to the project area to assist in the evaluation of geologic hazards that may be present. Besides, pertinent information (the documents cited in Section 14, *Reference*s) were used to understand the subsurface conditions and plan the investigation for this project.

4.2 Project Set-up

The project set-up consisted of the following tasks.

- Conducted a field reconnaissance and marked the boring locations.
- Notified Underground Service Alert (USA) at least 48 hours prior to drilling to clear the boring locations of any conflict with existing underground utilities.
- Coordinated with Kevin Lee from the City of Beaumont waste operator for access.
- Engaged a California-licensed driller company to drill exploratory borings.

4.3 Subsurface Exploration

Two exploratory borings (BH-01 and BH-02) was drilled on April 21, 2022, to investigate subsurface conditions at the project site. The borings were drilled using an 8-inch dimeter hollow stem auger to depths of 20.5 and 51.5 feet below existing ground surface (bgs).

Approximate boring location is indicated in Figure No. 2, *Approximate Boring Locations Map*. For a description of the field exploration and sampling program, see Appendix A, *Field Exploration*.

4.4 Laboratory Testing

Representative soil samples of the project site were tested in the laboratory to aid in the soils classification and to evaluate the relevant engineering properties of the soils. These tests included the following.

- *In*-situ moisture contents and dry densities (ASTM D2216 and ASTM D2937)
- Expansion index (ASTM D4829)
- R-value (California Test 301)
- Soil corrosivity (California Tests 643, 422, and 417)
- Collapse potential (ASTM D4546)
- Grain size distribution (ASTM D6913)
- Maximum dry density and optimum-moisture content (ASTM D1557)
- Direct shear (ASTM D3080)
- Consolidation (ASTM D2435)

For *in-situ* moisture and dry density data, see the Logs of Borings in Appendix A, *Field Exploration*. For a description of the laboratory test methods and test results, see Appendix B, *Laboratory Testing Program.*

4.5 Analysis and Report Preparation

Data obtained from the field exploration and laboratory testing program was compiled and evaluated. Geotechnical analyses of the compiled data were performed, and this report was prepared to present our findings, conclusions, and recommendations for the project.

5.0 LABORATORY TEST RESULTS

Results of physical and chemical tests performed for this project are presented below.

5.1 Physical Testing

Results of the various laboratory tests are presented in Appendix B, *Laboratory Testing Program*, except for the results of in-situ moisture and dry density tests which are

Project: Mesa Lift Station Upgrades

Location: Southeast Corner of the intersection of Potrero Blvd. & Castello Ln.
City of Beaumont, Riverside County, California

For: Albert Webb Associates

Approximate Boring Locations Map

Project No.
20-81-289-01

Converse Consultants

Figure No.
2

presented on the Logs of Borings in Appendix A, *Field Exploration.* The results are also discussed below.

- *In-situ* Moisture and Dry Density – In-situ dry density and moisture content of the soils were determined in accordance with ASTM Standard D2216 and D2937. Dry density of upper 10 feet soils of the site ranged from 116 to 132 pcf with moisture contents ranging from 7 to 11 percent. Results are presented in the logs of boring in Appendix A, Field Exploration.
- Expansion Index (EI) –Two representative sample from the upper 5 feet of soils was tested to evaluate the expansion potential in accordance with ASTM Standard D4829. The tests results showed EI of 0 and 16, corresponding to very low expansion potential.
- R-value – (California Test 301) One representative bulk soil sample was performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with California Test Method CT301 for resistance value (R-value). The test result showed R-value of 36.
- Collapse Potential – The collapse potential of two relatively undisturbed samples were tested under a vertical stress of up to 2.0 kips per square foot (ksf) in accordance with the ASTM Standard D4546 test method. The test results showed collapse potential of 0.7 and 1.0 percent, indicating slight collapse potential.
- Grain Size Analysis – Four representative samples were tested to determine the relative grain size distribution in accordance with the ASTM Standard D6913. The test results are graphically presented in Drawing No. B-1, *Grain Size Distribution Results.*
- Maximum Dry Density and Optimum Moisture Content – Typical moisture-density relationship test was performed on two representative samples in accordance with ASTM D1557. The results are presented in Drawing No. B-2, *Moisture-Density Relationship Results*, in Appendix B, *Laboratory Testing Program*. The laboratory maximum dry densities were found 129.0 and 133.5 pcf and the optimum moisture content were found 9.0 and 9.2 percent.
- Direct Shear –Two direct shear tests were performed on undisturbed representative ring samples under soaked moisture condition in accordance with ASTM Standard D3080. The results are presented in Drawings No. B-3, *Direct Shear Test Results* in Appendix B, *Laboratory Testing Program*.
- Consolidation Test – One consolidation test was performed on a relatively undisturbed sample of the site soil, in accordance with ASTM Standard D2435. The test result is shown on Drawing No. B-5, *Consolidation Test Results,* in Appendix B, *Laboratory Testing Program.*

5.2 Chemical Testing - Corrosivity Evaluation

Two representative soil samples were tested to determine minimum electrical resistivity, pH, and chemical content, including soluble sulfate and chloride concentrations. The purposes of these tests were to determine the corrosion potential of site soils when placed in contact with common construction and pipe materials. These tests were performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with California Tests 643, 422, and 417. The test results are presented in Appendix B, *Laboratory Testing Program* and summarized below.

- The pH measurement of the tested samples was 8.5 and 8.7.
- The sulfate content of the tested samples was 32 and 39 ppm.
- The chloride concentration of the tested samples was 20 and 21 ppm.
- The minimum electrical resistivity when saturated were 4,093 and 4,232 ohm-cm.

6.0 SITE CONDITIONS

A general description of the subsurface conditions, various materials and groundwater conditions encountered at the site during our field exploration is discussed below.

6.1 Subsurface Profile

Based on the exploratory borings and laboratory test results, the subsurface soils at the site encountered in the borings at various depths consists primarily of a mixture of sand, silt, and clay. For a detailed description of the subsurface materials encountered in the exploratory boring, see Drawing Nos. A-2a, A-2b and A-3, Logs of Borings, in Appendix A, Field Exploration.

6.2 Groundwater

Groundwater was not encountered during the investigation to the maximum explored depth of 51.5 feet bgs. For comparison, regional databases were accessed to search for relative groundwater level information, and the results are provided below.

The GeoTracker database (SWRCB, 2022) was reviewed to evaluate current and historical groundwater levels. No sites were identified within a 1.0-mile radius of the project site that contained groundwater elevation data.

The USGS National Water Information System (USGS, 2022) was reviewed to evaluate current and historical groundwater levels. Five results were returned in that search. Data from that record is listed in the table below.

Table No. 1, Summary of USGS Groundwater Depth Data

Alignment No.	Location	Groundwater Depth (ft. bgs)	Date Range
335621117013501	Unnamed road; approximately 3,287 feet west of project site	39.08-51.80	1921-2006
335709117004701	Morongo Golf Club; approximately 4,609 feet north of project site	244.00-255.40	1999-2002
335640117002501	Desert Lawn; approximately 2,965 feet northeast of project site	152.90-165.80	1921-1929
335603117000401	Western Lawn Ave.; approximately 4,645 feet southeast of project site	176.20-188.50	1998-2021
335603117000601	Western Lawn Ave.; approximately 4,548 feet southeast of project site	90.60-143.28	1926-2008

The California Department of Water Resources database (DWR, 2022) was reviewed to evaluate current and historical groundwater levels. No sites were identified within a 1.0-mile radius of the project site that contained groundwater elevation data.

Based on available data, the historical high groundwater level reported at wells within approximately one mile is 255.40 feet bgs. Groundwater was not encountered to a maximum explored depth of 51.5 feet during our exploratory boring and is not expected to be encountered during construction of the proposed project. It should be noted that the groundwater level could vary depending upon the seasonal precipitation and possible groundwater pumping activity in each site vicinity. Shallow perched groundwater may be present locally, particularly following precipitation or irrigation events.

6.3 Expansive Soils

Expansive soils are characterized by their ability to undergo significant volume changes (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors and may result in unacceptable settlement or heave of structures or concrete slabs supported on grade. Depending on the extent and location below finish subgrade, expansive soils can have a detrimental effect on structures. Based on the laboratory test results, the expansion index of the upper 5 feet of site soil were 0 and16, corresponds to very low expansion potential.

6.4 Collapse Potential

Soil deposits subjected to collapse/hydro-consolidation generally exist in regions of moisture deficiency. Collapsible soils are generally defined as soils that have potential to suddenly decrease in volume upon increase in moisture content even without an increase in external loads. Moreover, some soils may have a different degree of collapse/hydro-consolidation based on the amount of proposed fill or structure loads. Soils susceptible to collapse/ hydro-consolidation include wind-blown silt, weakly cemented sand, and silt where the cementing agent is soluble (e.g., soluble gypsum, halite), alluvial or colluvial deposits within semi-arid to arid climate, and certain weathered bedrock above the groundwater table.

Granular soils may have a potential to collapse upon wetting in arid climate regions. Collapse/hydro-consolidation may occur when the soluble cements (carbonates) in the soil matrix dissolve, causing the soil to densify from its loose/low density configuration from deposition.

The degree of collapse of a soil can be defined by the collapse potential value, which is expressed as a percent of collapse of the total sample using the Collapse Potential Test (ASTM D4546). According to the ASTM guideline, the severity of collapse potential is commonly evaluated by the following Table No. 2, *Collapse Potential Values*.

Table No. 2, Collapse Potential Values

Collapse Potential Value (%)	Severity of Problem
0	None
0.1 to 2	Slight
2.1 to 6.0	Moderate
6.0 to 10.0	Moderately Severe
>10	Severe

Based on the laboratory test results (collapse potential of 0.7 and 1.0 percent), a slight problem is anticipated at the site. Collapse potential distress is typically considered a concern when collapse potential is over 2% (LA County, 2013).

6.5 Excavatability

The surface and subsurface soil materials at the site are expected to be excavatable by conventional heavy-duty earth moving and trenching equipment.

The phrase “conventional heavy-duty excavation equipment” is intended to include commonly used equipment such as excavators and trenching machines. It does not include hydraulic hammers (“breakers”), jackhammers, blasting, or other specialized equipment and techniques used to excavate hard earth materials. Selection of an appropriate excavation equipment model should be done by an experienced earthwork contractor and may require test excavations in representative areas.

6.6 Subsurface Variations

Based on results of the subsurface exploration and our experience, some variations in the continuity and nature of subsurface conditions within the project site should be anticipated. Because of the uncertainties involved in the nature and depositional characteristics of the earth material, care should be exercised in interpolating or extrapolating subsurface conditions between or beyond the boring locations.

7.0 ENGINEERING GEOLOGY

The regional and local geology within the proposed project area is discussed below.

7.1 Regional Geology

The proposed project site is located within the northern Peninsular Ranges Geomorphic Province of Southern California. The Peninsular Ranges Geomorphic Province consists of a series of northwest-trending mountain ranges and valleys bounded on the north by the San Bernardino and San Gabriel Mountains, on the west by the Los Angeles Basin, and on the southwest by the Pacific Ocean.

The province is a seismically active region characterized by a series of northwest-trending strike-slip faults. The most prominent of the nearby fault zones include the San Jacinto and Elsinore faults, as well as the San Gorgonio and San Andreas fault zones (CGS, 2007), all of which have been known to be active during Quaternary time.

Topography within the province is generally characterized by broad alluvial valleys separated by linear mountain ranges. This northwest-trending linear fabric is created by the regional faulting within the granitic basement rock of the Southern California Batholith. Broad, linear, alluvial valleys have been formed by erosion of these principally granitic mountain ranges.

7.2 Local Geology

The project site is located on south-sloping alluvial fan within the San Gorgonio Pass, just north of the Badlands Mountain Range. Regional mapping (Matti and Morton, 2015) indicates that the subsurface is characterized by Pleistocene-aged alluvial fan deposits of sand and gravel from plutonic and gneissic detritus derived from the rising San Bernardino Mountains to the north and the Badlands Mountains to the south.

8.0 FAULTING AND SEISMICITY

The approximate distance and seismic characteristics of nearby faults as well as seismic design coefficients are presented in the following subsections.

8.1 Faulting

The proposed site is situated in a seismically active region. As is the case for most areas of Southern California, ground-shaking resulting from earthquakes associated with nearby and more distant faults may occur at the project site. During the life of the project, seismic activity associated with active faults can be expected to generate moderate to strong ground shaking at the site. Review of recent seismological and geophysical publications indicates that the seismic hazard for the project is high.

The project site is not located within a currently mapped State of California Earthquake Fault Zone for surface fault rupture. Table No. 3, *Summary of Regional Faults,* summarizes selected data of known faults capable of seismic activity within 100 kilometers of the site. The data presented below was calculated using the National Seismic Hazard Maps Database (USGS, 2008) and other published geologic data.

Table No. 3, Summary of Regional Faults

Fault Name and Section	Closest Distance (km)	Slip Sense	Length (km)	Slip Rate (mm/year)	Maximum Magnitude
San Jacinto	7.79	strike slip	241	n/a	7.88
S. San Andreas	13.67	strike slip	548	n/a	8.18
Pinto Mtn	30.06	strike slip	74	2.5	7.30
Cleghorn	41.82	strike slip	25	3	6.80
Elsinore	43.32	strike slip	241	n/a	7.85
Helendale-So Lockhart	46.49	strike slip	114	0.6	7.40
Cucamonga	47.52	thrust	28	5	6.70
North Frontal (West)	47.67	reverse	50	1	7.20
North Frontal (East)	48.28	thrust	27	0.5	7.00
Chino, alt 2	52.52	strike slip	29	1	6.80
Chino, alt 1	54.69	strike slip	24	1	6.70
Lenwood-Lockhart-Old Woman Springs	56.95	strike slip	145	0.9	7.50
Burnt Mtn	57.25	strike slip	21	0.6	6.80
Landers	60.41	strike slip	95	0.6	7.40
Eureka Peak	60.78	strike slip	19	0.6	6.70
San Jose	65.23	strike slip	20	0.5	6.70
Johnson Valley (No)	65.98	strike slip	35	0.6	6.90
Sierra Madre	69.94	reverse	57	2	7.20
Sierra Madre Connected	69.94	reverse	76	2	7.30
San Joaquin Hills	71.92	thrust	27	0.5	7.10
So Emerson-Copper Mtn	75.91	strike slip	54	0.6	7.10
Puente Hills (Coyote Hills)	78.93	thrust	17	0.7	6.90

Fault Name and Section	Closest Distance (km)	Slip Sense	Length (km)	Slip Rate (mm/year)	Maximum Magnitude
Calico-Hidalgo	82.69	strike slip	117	1.8	7.40
Clamshell-Sawpit	83.56	reverse	16	0.5	6.70
Newport Inglewood Connected alt 1	86.23	strike slip	208	1.3	7.50
Newport-Inglewood (Offshore)	86.23	strike slip	66	1.5	7.00
Newport Inglewood Connected alt 2	86.23	strike slip	208	1.3	7.50
Pisgah-Bullion Mtn-Mesquite Lk	91.04	strike slip	88	0.8	7.30
Newport-Inglewood, alt 1	92.52	strike slip	65	1	7.20

(Source: https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/)

8.2 CBC Seismic Design Parameters

Seismic parameters based on the 2019 California Building Code (CBSC, 2019) and ASCE 7-16 are provided in the following table. These parameters were determined using the generalized coordinates (33.940261N, 117.016129W) and the Seismic Design Maps ATC online tool.

Table No. 4, CBC Seismic Design Parameters

Seismic Parameters	
Site Coordinates	33.940261N, 117.0116129W
Risk Category	III
Site Class	D
Mapped Short period (0.2-sec) Spectral Response Acceleration, S_S	1.701g
Mapped 1-second Spectral Response Acceleration, S_1	0.623g
Site Coefficient (from Table 11.4-1), F_a	1.0
Site Coefficient (from Table 11.4-2), F_v	1.7
MCE 0.2-sec period Spectral Response Acceleration, S_{MS}	1.701g
MCE 1-second period Spectral Response Acceleration, S_{M1}	1.059g
Design Spectral Response Acceleration for short period S_{DS}	1.134g
Design Spectral Response Acceleration for 1-second period, S_{D1}	0.706g
Site Modified Maximum Peak Ground Acceleration, PGA_M	0.762g

8.3 Secondary Effects of Seismic Activity

In general, secondary effects of seismic activity include surface fault rupture, soil liquefaction, landslides, lateral spreading, and settlement due to seismic shaking, tsunamis, seiches, and earthquake-induced flooding. The site-specific potential for each of these seismic hazards is discussed in the following sections.

Surface Fault Rupture: The project site is not located within a currently designated State of California or Riverside County Earthquake Fault Zone (CGS, 2007; Riverside County, 2022). There are no known active faults projecting toward or extending across the project site. The potential for surface rupture resulting from the movement of nearby major faults is not known with certainty but is considered low.

Liquefaction: Liquefaction is defined as the phenomenon in which a cohesionless soil mass within the upper 50 feet of the ground surface suffers a substantial reduction in its shear strength, due to the development excess pore pressures. During earthquakes, excess pore pressures in saturated soil deposits may develop as a result of induced cyclic shear stresses, resulting in liquefaction.

Soil liquefaction generally occurs in submerged granular soils and non-plastic silts during or after strong ground shaking. There are several general requirements for liquefaction to occur and they are as follows.

- Soils must be submerged.
- Soils must be loose to medium-dense.
- Ground motion must be intense.
- Duration of shaking must be sufficient for the soils to lose shear resistance.

Based on a review of state and county hazard maps, the project site is located within an area not evaluated for liquefaction by State of California (CGS, 2007). The project site is located within a Riverside County (Riverside County, 2022) liquefaction zone designated as a low liquefaction potential. Based on the dynamic Settlement Analyses presented in Appendix C, *Liquefaction and Seismic Settlement Analysis*, we estimate that the liquefaction induced settlement potential for the site is negligible.

Seismic Settlement: Dynamic dry settlement may occur in loose, granular, unsaturated soils during a large seismic event. Classification of the samples and sampling blow counts indicate that the site is medium dense to dense and are sensitive to some seismically induced settlement. The potential for dry seismic settlement is not known with certainty, however due to the lack of shallow groundwater in the area the potential is considered negligible. Based on the dynamic Settlement Analyses presented in Appendix C, *Liquefaction and Seismic Settlement Analysis*, we estimate that the dry seismic settlement potential for the site is up to 0.4 inches.

Landslides: Seismically induced landslides and slope failures are common occurrences during or soon after large earthquakes. Due to the flat nature of the site and the distance away from any foothills, the potential for seismically induced landslides affecting the proposed site is considered to be very low.

Lateral Spreading: Seismically induced lateral spreading involves primarily lateral movement of earth materials over underlying materials which are liquefied due to ground shaking. It differs from the slope failure in that complete ground failure involving large movement does not occur due to the relatively smaller gradient of the initial ground surface. Lateral spreading is demonstrated by near-vertical cracks with predominantly horizontal movement of the soil mass involved. The topography at the project site and in the immediate vicinity is very flat. Under these circumstances, the potential for lateral spreading at the subject site is considered low.

Tsunamis: Tsunamis are large waves generated in open bodies of water by fault displacement or major ground movement. Due to the inland location of the site, tsunamis are not considered to be a risk.

Seiches: Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Due to the site far distance from bodies of water, seiches are not considered to be a risk.

Earthquake-Induced Flooding: Dams or other water-retaining structures may fail as a result of large earthquakes. Dams or other water-retaining structures may fail as a result of large earthquakes. The project site is not located within a designated dam inundation area (DSOD, 2022).

9.0 EARTHWORK RECOMMENDATIONS

Earthwork recommendations for the project are presented in the following sections.

9.1 General

This section contains our general recommendations regarding earthwork and grading for the project. These recommendations are based on the results of our field exploration, laboratory tests, our experience with similar projects, and data evaluation as presented in the preceding sections. These recommendations may require modification by the geotechnical consultant based on observation of the actual field conditions during grading.

Prior to the start of construction, all existing underground utilities and appurtenances should be located at the project site. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications. All excavations should be conducted in such a manner as not to cause loss of bearing and/or lateral support of existing utilities. All debris and deleterious material should be removed from the site.

If isolated pockets of very soft, loose, eroded, or pumping soil are encountered, the unstable soil should be excavated as needed to expose undisturbed, firm, and unyielding soils.

The contractor should determine the best manner to conduct the excavations, such that there are no losses of bearing and/or lateral support to the existing utilities (if any).

The final bottom surfaces of all excavations should be observed and approved by the project geotechnical consultant prior to placing any fill. Based on these observations, localized areas may require remedial grading deeper than indicated herein. Therefore, some variations in the depth and lateral extent of excavation recommended in this report should be anticipated.

9.2 Remedial Grading

Footings, slab-on-grade, concrete pads and pavements should be uniformly supported by compacted fill. In order to provide uniform support, structural areas should be overexcavated, scarified, and recompacted as follows.

Table No. 5, Overexcavation Depths

Structure/Pavement	Minimum Excavation Depth
Footings	24 inches below footings bottom or 3 feet below existing ground surface, whichever is deeper
Tank Bottom	5 feet below tank bottom footing and to extend at least 3 feet beyond the footprint of tank footings.
Slabs-on-grade	12 inches below slab bottom or 3 feet below existing ground surface, whichever is deeper
Concrete Pads	12 inches below pad bottom or 3 feet below existing ground surface, whichever is deeper
Pavements	12 inches below finish grade

The overexcavation below the footings, slab-on-grade, concrete pads and pavements should be uniform. The overexcavation should extend to at least 2 feet beyond the footprint of the slabs and pads, and at least 1 foot beyond the edge of the pavements. The overexcavation bottom should be scarified and compacted as described in Section 9.4, *Compacted Fill Placement*.

If isolated pockets of very soft, loose, eroded, or pumping soil are encountered, the unstable soil should be excavated as needed to expose undisturbed, firm, and unyielding soils.

The contractor should determine the best manner to conduct the excavations, such that there are no losses of bearing and/or lateral support to the existing structures or utilities.

Footings, slab-on-grade and concrete pad should be uniformly supported by compacted fill. In order to provide uniform support, structural areas should be generally overexcavated, scarified, and recompacted as follows.

9.3 Structural/Engineered Fill

No fill or aggregate base should be placed until excavations and/or natural ground preparation have been observed by the geotechnical consultant. The native soils encountered within the project site are generally considered suitable for re-use as compacted fill. Excavated soils should be processed, including removal of roots and debris, removal of oversized particles, mixing, and moisture conditioning, before placing as compacted fill. On-site soils used as fill should meet the following criteria.

- No particles larger than 3 inches in largest dimension.
- Rocks larger than one inch should not be placed within the upper 12 inches of subgrade soils.
- Free of all organic matter, debris, or other deleterious material.
- Expansion index of 40 or less.
- Sand Equivalent greater than 15 (greater than 30 for pipe bedding).
- Contain less than 30 percent by weight retained in 3/4-inch sieve.
- Contain less than 40 percent fines (passing #200 sieve).

Based on field investigation and laboratory testing results, on-site soils may be suitable as fill materials.

Imported materials, if required, should meet the above criteria prior to being used as compacted fill. Any imported fills should be tested and approved by geotechnical representative prior to delivery to the site.

9.4 Compacted Fill Placement

All surfaces to receive structural fills should be scarified to a depth of 6 inches. The soil should be moisture conditioned to within ±3 percent of optimum moisture content for coarse soils and 0 to 2 percent above optimum moisture content for fine soils. The scarified soils should be recompacted to at least 90 percent of the laboratory maximum dry density.

Fill soils should be thoroughly mixed, and moisture conditioned to within ±3 percent of optimum moisture content for coarse soils and 0 to 2 percent above optimum moisture content for fine soils. Fill soils should be evenly spread in horizontal lifts not exceeding 8 inches in uncompacted thickness.

All fill placed at the site should be compacted to at least 90 percent of the laboratory maximum dry densities as determined by ASTM Standard D1557 test method unless a higher compaction is specified herein.

To reduce differential settlement, variations in the soil type, degree of compaction and thickness of the engineered fill placed underneath the foundations should be minimized.

Fill materials should not be placed, spread, or compacted during unfavorable weather conditions. When site grading is interrupted by heavy rain, filling operations should not resume until the geotechnical consultant approves the moisture and density conditions of the previously placed fill.

9.5 Backfill Recommendations Behind Subterranean Wall

Compaction of backfill adjacent to structural walls can produce excessive lateral pressures. Improper types and locations of compaction equipment and/or compaction techniques may damage the walls. The use of heavy compaction equipment should not be permitted within a horizontal distance of 5 feet from the wall. Backfill behind any structural walls within the recommended 5-foot zone should be compacted using lightweight construction equipment such as handheld compactors to avoid overstressing the walls. The compaction of wall backfill should be conducted procedure described in section 9.4 *Compaction Fill Placement.*

9.6 Shrinkage and Subsidence

The volume of excavated and recompacted soils will decrease as a result of grading. The shrinkage would depend on, among other factors, the depth of cut and/or fill, and the grading method and equipment utilized. Based on our previous experience in the other projects in close vicinity of this site, for the preliminary estimation, shrinkage factors for various units of earth material at the site may be taken as presented below.

- The shrinkage factor (defined as a percentage of soil volume reduction when moisture conditioned and compacted to the average of 92 percent relative compaction) of fill is estimated. An average value of 3 percent may be used for preliminary earthwork planning.
- Subsidence (defined as the settlement of native materials from the equipment load applied during grading) would depend on the construction methods including type of equipment utilized. Ground subsidence is estimated to be approximately 0.1 foot to 0.15 foot.

Although these values are only approximate, they represent our best estimates of the factors to be used to calculate lost volume that may occur during grading. If more accurate shrinkage and subsidence factors are needed, it is recommended that field-testing using the actual equipment and grading techniques be conducted.

9.7 Site Drainage

Adequate positive drainage should be provided away from the site and excavation areas to prevent ponding and to reduce percolation of water into the foundation soils. Surface drainage should be directed to suitable non-erosive devices.

9.8 Utility Trench Backfill

The following sections present earthwork recommendations for utility trench backfill, including subgrade preparation and trench zone backfill.

Open cuts adjacent to existing roadways or structures are not recommended within a 1:1 (horizontal:vertical) plane extending down and away from the roadway or structure perimeter (if any).

Soils from the trench excavation should not be stockpiled more than 6 feet in height or within a horizontal distance from the trench edge equal to the depth of the trench. Soils should not be stockpiled behind the shoring, if any, within a horizontal distance equal to the depth of the trench, unless the shoring has been designed for such loads.

9.8.1 Pipeline Subgrade Preparation

The final subgrade surface should be level, firm, uniform, and free of loose materials and properly graded to provide uniform bearing and support to the entire section of the pipe placed on bedding material. Protruding oversize particles larger than 2 inches in dimension, if any, should be removed from the trench bottom and replaced with compacted on-site materials.

Any loose, soft and/or unsuitable materials encountered at the pipe subgrade should be removed and replaced with an adequate bedding material. During the digging of depressions for proper sealing of the pipe joints, the pipe should rest on a prepared bottom for as near its full length as is practicable.

9.8.2 Pipe Bedding

Bedding is defined as the material supporting and surrounding the pipe to 1 foot above the pipe. <u>Pipe bedding should follow City of Beaumont Standards</u>. If additional recommendations beyond City of Beaumont Standards are needed, the following specifications can be used during the placement of pipe bedding.

To provide uniform and firm support for the pipe, compacted granular materials such as clean sand, gravel or ¾-inch crushed aggregate, or crushed rock may be used as pipe bedding material. Typically, soils with sand equivalent value of 30 or more are used as pipe bedding material. The pipe designer should determine if the soils are suitable as pipe bedding material.

The type and thickness of the granular bedding placed underneath and around the pipe, if any, should be selected by the pipe designer. The load on the rigid pipes and deflection of flexible pipes and, hence, the pipe design, depends on the type and the amount of bedding placed underneath and around the pipe.

Bedding materials should be vibrated in-place to achieve compaction. Care should be taken to densify the bedding material below the springline of the pipe. Prior to placing the pipe bedding material, the pipe subgrade should be uniform and properly graded to provide uniform bearing and support to the entire section of the pipe placed on bedding material. During the digging of depressions for proper sealing of the pipe joints, the pipe should rest on a prepared bottom for as near its full length as is practicable.

Migration of fines from the surrounding native and/or fill soils must be considered in selecting the gradation of any imported bedding material. We recommend that the pipe bedding material should satisfy the following criteria to protect migration of fine materials.

i. $\frac{D15(F)}{D85(B)} \leq 5$

ii. $\frac{D50(F)}{D50(B)} < 25$

iii. Bedding Materials must have less than 5 percent passing No. 200 sieve (0.0074 mm) to avoid internal movement of fines.

Where,
F = Bedding Material
B = Surrounding Native and/or Fill Soils
*D*15(F) = Particle size through which 15% of bedding material will pass
*D*85(B) = Particle size through which 85% of surrounding soil will pass
*D*50(F) = Particle size through which 50% of bedding material will pass
*D*50(B) = Particle size through which 50% of surrounding soil will pass

If the above criteria do not satisfy, commercially available geofabric used for filtration purposes (such as Mirafi 140N or equivalent) may be wrapped around the bedding material encasing the pipe to separate the bedding material from the surrounding native or fill soils.

9.8.3 Trench Zone Backfill

The trench zone is defined as the portion of the trench above the pipe bedding extending up to the final grade level of the trench surface. Excavated site soil free of oversize particles and deleterious matter may be used to backfill the trench zone. <u>Trench backfill</u>

should follow City of Beaumont. If additional recommendations beyond the City Standards are needed, the following specifications can be used during the placement of trench backfill.

- Trench excavations to receive backfill should be free of trash, debris or other unsatisfactory materials at the time of backfill placement.
- Trench zone backfill should be compacted to at least 90 percent of the laboratory maximum dry density as per ASTM D1557 test method. At least the upper 1 foot of trench backfill underlying pavement should be compacted to at least 95 percent of the laboratory maximum dry density as per ASTM D1557 test method.
- Particles larger than 1 inch should not be placed within 12 inches of the pavement subgrade. No more than 30 percent of the backfill volume should be larger than ¾-inch in the largest dimension. Gravel should be well mixed with finer soil. Rocks larger than 3 inches in the largest dimension should not be placed as trench backfill.
- Trench backfill should be compacted by mechanical methods, such as sheepsfoot, vibrating or pneumatic rollers or mechanical tampers to achieve the density specified herein. The backfill materials should be brought to within ± 3 percent of optimum moisture content for coarse-grained soil, and between optimum and 2 percent above optimum for fine-grained soil, then placed in horizontal layers. The thickness of uncompacted layers should not exceed 8 inches. Each layer should be evenly spread, moistened or dried as necessary, and then tamped or rolled until the specified density has been achieved.
- The contractor should select the equipment and processes to be used to achieve the specified density without damage to adjacent ground, structures, utilities and completed work.
- The field density of the compacted soil should be measured by the ASTM D1556 (Sand Cone) or ASTM D6938 (Nuclear Gauge) or equivalent.
- Observations and field tests should be performed by the project soils consultant to confirm that the required degree of compaction has been obtained. Where compaction is less than that specified, additional compactive effort should be made with adjustment of the moisture content as necessary, until the specified compaction is obtained.
- It should be the responsibility of the contractor to maintain safe working conditions during all phases of construction.
- Trench backfill should not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rain, fill operations should not resume until field tests by the project's geotechnical consultant indicate that the moisture content and density of the fill are in compliance with project specifications.

10.0 DESIGN RECOMMENDATIONS

The various design recommendations provided in this section are based on the assumption that the above earthwork and grading recommendations will be implemented in the project design and construction.

10.1 Shallow Foundation Design Parameters

The proposed equipment pads and walls may be supported on continuous spread and/or isolated spread footings. The design of the shallow foundations should be based on the recommended parameters presented in the table below.

Table No. 6, Recommended Foundation Parameters

Parameter	Value
Minimum continuous footing width	18 inches
Minimum isolated footing width	18 inches
Minimum continuous or isolated footing depth of embedment below lowest adjacent grade	18 inches
Allowable net bearing capacity	3,500 psf

The actual footing dimensions and reinforcement should be based on structural design. The allowable bearing capacity can be increased by 500 psf with each foot of additional embedment and 100 psf with each foot of additional width up to a maximum of 4,500 psf.

The net allowable bearing values indicated above are for the dead loads and frequently applied live loads and are obtained by applying a factor of safety of 3.0 to the net ultimate bearing capacity. If normal code requirements are applied for design, the above vertical bearing value may be increased by 33 percent for short duration loadings, which will include loadings induced by wind or seismic forces.

10.2 Mat Foundation Design Parameters

The proposed equipment pad may be designed as mat foundation. The modulus of subgrade reaction (k) for design of flexible mat foundation was estimated from the available soil compressibility data and published charts. For design of flexible mat foundation, the following equation may be used.

$$k = k_1[(B+1)/2B]^2$$

Where:
k= vertical modulus of subgrade reaction for mat foundation, kips per cubic feet
k_1= 200 kcf, normalized modulus of subgrade reaction for 1-square-foot footing
B= foundation width, feet

Other necessary parameters (modulus of elasticity and Poisson's ratio) for mat foundation design are as follows.

$E = 33\ W_c^{1.5}\ f_c^{\ 0.5}$ psi
Where, E = Modulus of Elasticity of Concrete (psi)
W_c = weight of concrete (pcf)
f_c = compressive strength of concrete at 28 days (psi)
ν = 0.35, Poisson's Ratio

An allowable net bearing capacity of 3,500 psf may be used for mat foundations founded on compacted native soil. The mat should be reinforced with top and bottom steel, as appropriate, to provide structural continuity and to permit spanning of local irregularities. The mat foundation dimensions, and reinforcement should be based on structural design. For design purposes, the self-weight of the mat foundation can be negligible.

10.3 Soil Parameters for Pipe Design

Structural design requires proper evaluation of all possible loads acting on pipe. The stresses and strains induced on buried pipe depend on many factors, including the type of soil, density, bearing pressure, angle of internal friction, coefficient of passive earth pressure, and coefficient of friction at the interface between the backfill and native soils. The recommended values of the various soil parameters for design are provided in the following table.

Table No. 7, Soil Parameters for Pipe Design

Soil Parameters	Value
Average compacted fill total unit weight (assuming 92% relative compaction), γ (pcf)	140
Angle of internal friction of soils, ϕ	33
Soil cohesion, c (psf)	80
Coefficient of friction between concrete and native soils, fs	0.35
Coefficient of friction between steel pipe and native soils, fs	0.25
Bearing pressure against native soils (psf)	3,500
Coefficient of passive earth pressure, Kp	3.39
Coefficient of active earth pressure, Ka	0.29
Modulus of Soil Reaction E' (psi)	1,500

10.4 Bearing Pressure for Anchor and Thrust Blocks

An allowable net bearing pressure presented in Table No. 7, *Soil Parameters for Pipe Design* may be used for anchor and thrust block design against alluvial soils. Such thrust blocks should be at least 18 inches wide.

If normal code requirements are applied for design, the above recommended bearing capacity and passive resistances may be increased by 33 percent for short duration loading such as seismic or wind loading.

10.5 Lateral Earth Pressures and Resistance to Lateral Loads

In the following subsections, the lateral earth pressures and resistance to lateral loads are estimated by using on-site native soils strength parameters obtained from laboratory testing.

10.5.1 Active Earth Pressures

The active earth pressure behind any buried wall or foundation depends primarily on the allowable wall movement, type of backfill materials, backfill slopes, wall or foundation inclination, surcharges, and any hydrostatic pressures. The lateral earth pressures are presented in the following table.

Table No. 8, Active and At-Rest Earth Pressures

Loading Conditions	Lateral Earth Pressure (psf/ft depth)
Active earth conditions (wall is free to deflect at least 0.001 radian)	38
At-rest (wall is restrained)	59

These pressures assume no surcharge, and no hydrostatic pressure. If water pressure is allowed to build up behind the walls, the active pressures should be reduced by 50 percent and added to a full hydrostatic pressure to compute the design pressures against the walls.

A uniform lateral pressure of 100 psf should be considered to account for normal vehicular and construction traffic within 10 feet of the structures.

10.5.2 Resistance to Lateral Loads

Resistance to lateral loads can be assumed to be provided by a combination of friction acting at the base of foundations and by passive earth pressure. A coefficient of friction of 0.35 between formed concrete and soil may be used with the dead load forces. An allowable passive earth pressure of 200 psf per foot of depth may be used for the sides of the footing poured against recompacted native soils. A factor of safety of 1.5 was applied in calculating passive earth pressure. The maximum value of the passive earth pressure should be limited to 3,500 psf.

Vertical and lateral bearing values indicated above are for the total dead loads and frequently applied live loads. If normal code requirements are applied for design, the above vertical bearing and lateral resistance values may be increased by 33 percent for short duration loading, which will include the effect of wind or seismic forces.

Due to the low overburden stress of the soil at shallow depth, the upper 1 foot of passive resistance should be neglected unless the soil is confined by pavement or slab.

10.5.3 Seismic Earth Pressure

The seismic force applied to the wall is based on a horizontal seismic acceleration coefficient equal to one-third of the peak ground. An equivalent fluid seismic pressure of 27H pcf may be assumed under active loading conditions (regular triangular pressure distribution) where H is the height of the backfill behind the wall.

10.6 Settlement

The total settlement of mat foundation from static structural loads and short-term settlement of properly compacted fill is anticipated to be 1 inch or less. The differential settlement resulting from static loads is anticipated to be 0.5 inches or less over a horizontal distance of 40 feet.

Our analysis of the potential dynamic settlement is presented in Appendix C, *Liquefaction and Settlement Analysis.* We estimate that the site has negligible potential for liquefaction induced settlement with up to 0.4 inches of dry seismic settlement. The soil profile across the site is relatively similar. So, we anticipate that the total settlement will be uniform. We recommend that the planned structure be designed in anticipation of dynamic differential settlement of 0.5 inches in 40 horizontal feet.

Generally, the static and dynamic settlement does not occur at the same time. For design purposes, the structural engineer should decide whether static and dynamic settlement will be combined or not.

10.7 Soil Corrosivity

Two representative soil sample was evaluated for corrosivity with respect to common construction materials such as concrete and steel. The test results are presented in Appendix B, *Laboratory Testing Program* and general discussion of the test results are presented below. <u>However, Converse does not practice in the area of corrosion consulting and cannot provide mitigation recommendations.</u>

Soil pH values were found 8.5 and 8.7, which indicates soil is alkaline in nature.

The sulfate contents of the sampled soil correspond to American Concrete Institute (ACI) exposure category S0 for the sulfate concentration (ACI 318-14, Table 19.3.1.1). No concrete type restrictions are specified for exposure category S0 (ACI 318-14, Table 19.3.2.1). A minimum compressive strength of 2,500 psi is recommended.

We anticipate that concrete will be exposed to moisture from precipitation and irrigation. Based on the project location and the results of chloride testing of the soils, we do not anticipate that concrete structures will be exposed to external sources of chlorides, such as deicing chemicals, salt, brackish water, or seawater. ACI specifies exposure category C1 where concrete is exposed to moisture, but not to external sources of chlorides (ACI 318-14, Table 19.3.1.1). ACI provides concrete design recommendations in ACI 318-14, Table 19.3.2.1, including a compressive strength of at least 2,500 psi and a maximum chloride content of 0.3 percent.

According to Romanoff, 1957, the following table provides general guideline of soil corrosion based on electrical resistivity.

Table No. 9, Correlation Between Resistivity and Corrosion

Soil Resistivity (ohm-cm) per Caltrans CT 643	Corrosivity Category
Over 10,000	Mildly corrosive
2,000 – 10,000	Moderately corrosive
1,000 – 2,000	corrosive
Less than 1,000	Severe corrosive

The measured value of the minimum electrical resistivity of the sample when saturated were 4,093 and 4,232 ohm-cm for the site. <u>This indicates that the soils tested are moderately corrosive to ferrous metals in contact with the soil</u>. <u>If needed, a qualified corrosion consultant should provide appropriate corrosion mitigation measures for any ferrous metals and concrete materials in contact with the site soils.</u>

10.8 Asphalt Concrete Pavement

For pavement design, we have utilized design R-value of 36 and Traffic Indices (TIs) ranging from 5 to 8.

Based on the above information, asphalt concrete and aggregate base thickness are determined using the *Caltrans Highway Design Manual (Caltrans, 2021)*, Chapter 630 with a safety factor of 0.2 for asphalt concrete/aggregate base Section and 0.1 for full depth asphalt concrete section. Minimum TI, asphalt pavement and aggregate base thickness requirements were also considered in the pavement designs. Preliminary asphalt concrete pavement sections for each street are presented in the following table.

Table No. 10, Recommended Pavement Sections

Design R-value	Traffic Index (TI)	Pavement Section		
		Asphalt Concrete (inches)	Aggregate Base (inches)	Full AC Section (inches)
36	5.0	3.0	4.5	5.5
	6.0	4.0	5.0	7.0
	7.0	4.5	7.0	8.0
	8.0	5.5	8.0	9.5

Pavement sections should follow Table No. 10, *Recommended Pavement Sections* or the City of Beaumont Standards, whichever is applicable. At or near the completion of grading, the subgrade should be tested to evaluate the actual subgrade R-value for final pavement design.

Prior to placement of aggregate base or asphalt concrete, at least the upper 12 inches of subgrade soils should be scarified, moisture-conditioned if necessary, and recompacted to at least 95 percent of the laboratory maximum dry density as defined by ASTM Standard D1557 test method.

Base materials should conform to Section 200-2.2,"*Crushed Aggregate Base*," of the current Standard Specifications for Public Works Construction (SSPWC; Public Works Standards, 2018) or the City of Beaumont Standards, whichever is applicable and should be placed in accordance with Section 301-2 of the SSPWC.

Asphaltic concrete materials should conform to Section 203 of the SSPWC or the City of Beaumont Standards, whichever is applicable and should be placed in accordance with Section 302-5 of the SSPWC.

11.0 CONSTRUCTION RECOMMENDATIONS

Temporary sloped excavation and shoring design recommendations are presented in the following sections.

11.1 General

Prior to the start of construction, all existing underground utilities should be located at the project site. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications.

Sloped excavations may not be feasible in locations adjacent to existing utilities, pavement, or structures. Recommendations pertaining to temporary excavations are presented in this section.

Excavations near existing structures may require vertical side wall excavation. Where the side of the excavation is a vertical cut, it should be adequately supported by temporary shoring to protect workers and any adjacent structures.

All applicable requirements of the California Construction and General Industry Safety Orders, the Occupational Safety and Health Act, and the Construction Safety Act should be met. The soils exposed in cuts should be observed during excavation by the geotechnical consultant and the competent person designated by the contractor. If potentially unstable soil conditions are encountered, modifications of slope ratios for temporary cuts may be required.

11.2 Temporary Sloped Excavations

Temporary open-cut trenches may be constructed with side slopes as recommended in the following table. Temporary cuts encountering soft and wet fine-grained soils; dry loose, cohesionless soils or loose fill from trench backfill may have to be constructed at a flatter gradient than presented below.

Table No. 11, Slope Ratios for Temporary Excavations

Soil Type	OSHA Soil Type	Depth of Cut (feet)	Recommended Maximum Slope (Horizontal:Vertical)[1]
Sandy Silt (ML), Silty Sand (SM)*	C	0-10	1.5:1

* Slope ratio assumed to be uniform from top to toe of slope.

For shallow excavations up to 4 feet bgs can be vertical. For steeper temporary construction slopes or deeper excavations, or unstable soil encountered during the excavation, shoring or trench shields should be provided by the contractor to protect the workers in the excavation.

Surfaces exposed in slope excavations should be kept moist but not saturated to retard raveling and sloughing during construction. Adequate provisions should be made to protect the slopes from erosion during periods of rainfall. Surcharge loads, including construction materials, should not be placed within 5 feet of the unsupported slope edge. Stockpiled soils with a height higher than 6 feet will require greater distance from trench edges.

11.3 Shoring Design

Temporary shoring will be required where open sloped excavations will not be feasible due to unstable soils or due to nearby existing structures or facilities. Temporary shoring may consist of conventional soldier piles and lagging or sheet piles or any piles selected by contractor. The shoring for the pipe excavations may be laterally supported by walers and cross bracing or may be cantilevered. Drilled excavations for soldier piles will require the use of drilling fluids to prevent caving and to maintain an opened hole for pile installation.

The active earth pressure behind any shoring depends primarily on the allowable movement, type of backfill materials, backfill slopes, wall inclination, surcharges, and any hydrostatic pressures.

The lateral earth pressures to be used in the design of shoring is presented in the following table.

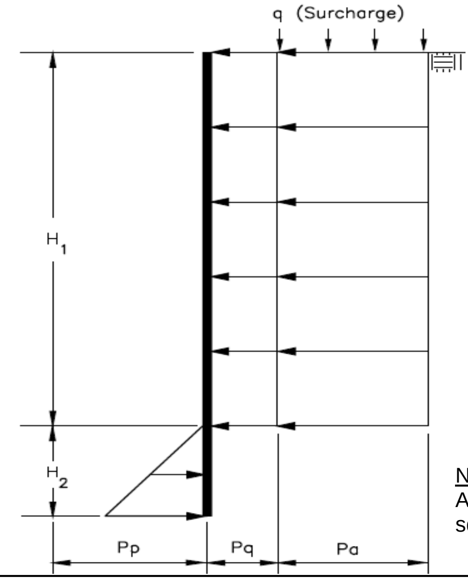
Table No. 12, Lateral Earth Pressures for Temporary Shoring

Lateral Resistance Soil Parameters*	Value
Active Earth Pressure (Braced Shoring) (psf) (A)	26
Active Earth Pressure (Cantilever Shoring) (psf) (B)	45
At-Rest Earth Pressure (Cantilever Shoring) (psf) (C)	66
Passive earth pressure (psf per foot of depth) (D)	200
Maximum allowable bearing pressure against native soils (psf) (E)	3,500
Coefficient of friction between sheet pile and native soils, fs (F)	0.25

* Parameters A through F are used in Figures No. 4 and 5 below.

Restrained (braced) shoring systems should be designed based on Figure No. 3, *Lateral Earth Pressures for Temporary Braced Excavation* to support a uniform rectangular lateral earth pressure.

Figure No. 3, Lateral Earth Pressures for Temporary Braced Excavation



Total Earth Pressure, P

P = Pq + Pa

Pq = 0.5q - incremental surcharge pressure

Pa = (A)H_1 - active earth pressure (Braced walls)

Lateral Pressure Resistance

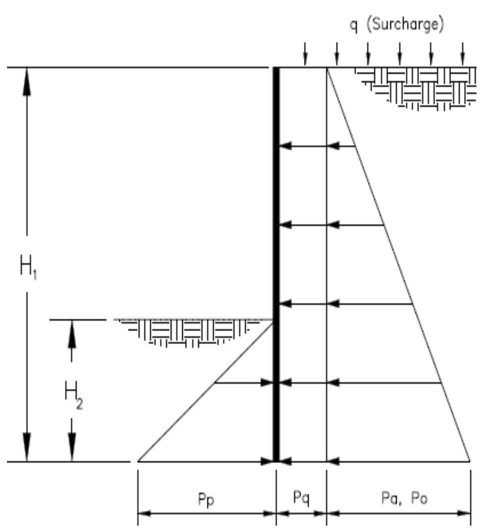
Pp = (D) H_2 ≤ (E) psf - passive earth pressure (on native soils)

μ = (F) - ultimate friction coefficient between steel sheet piles and soil

Note:
All values of height (H) in feet, pressure (P) and surcharge (q) in pounds per square foot (psf).

Unrestrained (cantilever) design of cantilever shoring consisting of soldier piles spaced at least two diameters on-center or sheet piles, can be based on Figure No. 4, *Lateral Earth Pressures on Temporary Cantilever Wall*.

Figure No. 4, Lateral Earth Pressures on Temporary Cantilever Wall



Total Earth Pressure, P

P = Pq + Pa, Po

Pq = 0.5q - incremental surcharge pressure

Pa = (B)H_1 - active earth pressure (Un-restrained)

Po = (C)H_1 - at rest earth pressure (Restrained)

Lateral Pressure Resistance

Pp = (D) H_2 ≤ (E) psf - passive earth pressure (on native soils)

μ = (F) - ultimate friction coefficient between steel sheet piles and soil

Note:
All values of height (H) in feet, pressure (P) and surcharge (q) in pounds per square foot (psf).

The provided pressures assume no hydrostatic pressures. If hydrostatic pressures are allowed to build up, the incremental earth pressures below the ground-water level should be reduced by 50 percent and added to hydrostatic pressure for total lateral pressure.

Passive resistance includes a safety factor of 1.5. The upper 1 foot for passive resistance should be ignored unless the surface is confined by a pavement or slab.

In addition to the lateral earth pressure, surcharge pressures due to miscellaneous loads, such as soil stockpiles, vehicular traffic or construction equipment located adjacent to the shoring, should be included in the design of the shoring. A uniform lateral pressure of 100 psf should be included in the upper 10 feet of the shoring to account for normal vehicular and construction traffic within 10 feet of the trench excavation. As previously mentioned, all shoring should be designed and installed in accordance with state and federal safety regulations.

The contractor should have provisions for soldier pile and sheet pile removal. All voids resulting from removal of shoring should be filled. The method for filling voids should be selected by the contractor, depending on construction conditions, void dimensions and available materials. The acceptable materials, in general, should be non-deleterious, and able to flow into the voids created by shoring removal (e.g., concrete slurry, “pea” gravel, etc.).

Excavations for the proposed pipeline should not extend below a 1:1 horizontal:vertical (H:V) plane extending from the bottom of any existing structures, utility lines or streets. Any proposed excavation should not cause loss of bearing and/or lateral supports of the existing utilities or streets.

If the excavation extends below a 1:1 (H:V) plane extending from the bottom of the existing structures, utility lines or streets, a maximum of 10 feet of slope face parallel to the existing improvement should be exposed at a time to reduce the potential for instability. Backfill should be accomplished in the shortest period of time and in alternating sections.

12.0 GEOTECHNICAL SERVICES DURING CONSTRUCTION

The project geotechnical consultant should review plans and specifications as the project design progresses. Such review is necessary to identify design elements, assumptions, or new conditions which require revisions or additions to our geotechnical recommendations.

The project geotechnical consultant should be present to observe conditions during construction. Geotechnical observation and testing should be performed as needed to verify compliance with project specifications. Additional geotechnical recommendations may be required based on subsurface conditions encountered during construction.

13.0 CLOSURE

This report is prepared for the project described herein and is intended for use solely by Albert A. Webb Associates and their authorized agents to assist in the design and construction of the proposed project. Our findings and recommendations were obtained in accordance with generally accepted professional principles practiced in geotechnical engineering. We make no other warranty, either expressed or implied.

Converse Consultants is not responsible or liable for any claims or damages associated with interpretation of available information provided to others. Field exploration identifies actual soil conditions only at those points where samples are taken, when they are taken. Data derived through sampling and laboratory testing is extrapolated by Converse employees who render an opinion about the overall soil conditions. Actual conditions in areas not sampled may differ. In the event that changes to the project occur, or additional, relevant information about the project is brought to our attention, the recommendations contained in this report may not be valid unless these changes and additional relevant information are reviewed, and the recommendations of this report are modified or verified in writing. In addition, the recommendations can only be finalized by observing actual subsurface conditions revealed during construction. Converse cannot be held responsible for misinterpretation or changes to our recommendations made by others during construction.

As the project evolves, continued consultation and construction monitoring by a qualified geotechnical consultant should be considered an extension of geotechnical investigation services performed to date. The geotechnical consultant should review plans and specifications to verify that the recommendations presented herein have been appropriately interpreted, and that the design assumptions used in this report are valid. Where significant design changes occur, Converse may be required to augment or modify the recommendations presented herein. Subsurface conditions may differ in some locations from those encountered in the explorations, and may require additional analyses and, possibly, modified recommendations.

Design recommendations given in this report are based on the assumption that it will be implemented. Additional consultation may be prudent to interpret Converse's findings for contractors, or to possibly refine these recommendations based upon the review of the actual site conditions encountered during construction. If the scope of the project changes, if project completion is to be delayed, or if the report is to be used for another purpose, this office should be consulted.

14.0 REFERENCES

AMERICAN CONCRETE INSTITUTE (ACI), 2014, Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary, October 2014.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE), 2017, Minimum Design Loads for Buildings and Other Structures, SEI/ASCE Standard No. 7-16, dated 2017.

CALIFORNIA BUILDING STANDARDS COMMISSION (CBSC), 2019, California Building Code (CBC).

CALIFORNIA DEPARTMENT OF WATER RESOURCES (DWR), 2022, Water Data Library (http://wdl.water.ca.gov/waterdatalibrary/), accessed June 2022.

CALIFORNIA GEOLOGICAL SURVEY (CGS), 2007, Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Faulting Zoning Act with Index to Earthquake Fault Zone Maps, Special Publication 42, revised 2007.

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD (SWRCB), 2022, GeoTracker database (http://geotracker.waterboards.ca.gov/), accessed June 2022.

DAS, B.M., 2011, Principles of Foundation Engineering, Seventh Edition, published by Global Engineering, 2011.

DEPARTMENT OF WATER RESOURCES - DIVISION OF SAFETY OF DAMS (DSOD), 2022, California Dam Breach Inundation Maps, (https://fmds.water.ca.gov/webgis/?appid=dam_prototype_v2), accessed June 2022.

MATTI, J.C., MORTON, D.M. and LANGANHEIM, V.E., 2015 Geologic and Geophysical Maps of the El Casco 7.5′ quadrangle, Riverside County, Southern California, with accompanying geologic-map database, California, U.S Geologic Survey Open-File Report OF-2010-1274, scale 1:24000

ROMANOFF, MELVIN, 1957, Underground Corrosion, National Bureau of Standards Circular 579, dated April 1957.

U.S. GEOLOGICAL SURVEY (USGS), 2022, National Water Information System: Web Interface (http://nwis.waterdata.usga.gov/nwis/gwlevels), accessed June 2022.

U.S. GEOLOGIC SURVEY, 2008 National Seismic Hazard Maps – Source Parameters, https://earthquake.usgs.gov/cfusion/hazfaults_2008_search.

Appendix A

Field Exploration

APPENDIX A

FIELD EXPLORATION

Our field investigation included a site reconnaissance and a subsurface exploration program consisting of drilling soil borings. During the site reconnaissance, the surface conditions were noted, and the borings were marked at the locations approved by Bradley Sackett with Albert A. Webb Associates. The approximate boring locations were established in the field with reference to existing landmarks and other visible features. The locations should be considered accurate only to the degree implied by the method used.

Two exploratory borings (BH-01 and BH-02) were drilled on April 21, 2022, to investigate the subsurface conditions at the site. The borings were drilled to the depths of 20.5 and 51.5 below existing ground surface (bgs).

The borings were advanced using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers for soils sampling. Encountered materials were continuously logged by a Converse Engineer and classified in the field by visual classification in accordance with the Unified Soil Classification System. Where appropriate, the field descriptions and classifications have been modified to reflect laboratory test results.

Relatively undisturbed samples were obtained using California Modified Samplers (2.4 inches inside diameter and 3.0 inches outside diameter) lined with thin sample rings. The steel ring sampler was driven into the bottom of the borehole with successive drops of a 140-pound driving weight falling 30 inches. Blow counts at each sample interval are presented on the boring logs. Samples were retained in brass rings (2.4 inches inside diameter and 1.0 inch in height) and carefully sealed in waterproof plastic containers for shipment to the Converse laboratory. Bulk samples of typical soil types were also obtained.

Standard Penetration Testing (SPT) was also performed in accordance with the ASTM Standard D1586 test method at 10-foot intervals beginning at 20 feet bgs in the 50 feet deep boring using a standard (1.4 inches inside diameter and 2.0 inches outside diameter) split-barrel sampler. The mechanically driven hammer for the SPT sampler was 140 pounds, falling 30 inches for each blow. The recorded blow counts for every 6 inches for a total of 1.5 feet of sampler penetration are shown on the Logs of Boring.

The exact depths at which material changes occur cannot always be established accurately. Unless a more precise depth can be established by other means, changes in material conditions that occur between drive samples are indicated on the logs at the top of the next drive sample.

Following the completion of logging and sampling, the borings were backfilled with soil cuttings mixed with cement and compacted by pushing down with augers using the drill rig weight. If construction is delayed, the surface of the borings may settle over time. We recommend the owner monitor the boring locations and backfill any depression that might occur or provide protection around the boring locations to prevent trip and fall injuries from occurring near the area of any potential settlement.

For a key to soil symbols and terminology used in the borings log, refer to Drawing No. A-1a and A-1b, *Unified Soil Classification and Key to Boring Log Symbols*. For logs of borings, see Drawing Nos. A-2a, A-2b and A-3, *Logs of Boring*.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

FIELD AND LABORATORY TESTS

- **C** Consolidation (ASTM D 2435)
- **CL** Collapse Potential (ASTM D 4546)
- **CP** Compaction Curve (ASTM D 1557)
- **CR** Corrosion, Sulfates, Chlorides (CTM 643-99; 417; 422)
- **CU** Consolidated Undrained Triaxial (ASTM D 4767)
- **DS** Direct Shear (ASTM D 3080)
- **EI** Expansion Index (ASTM D 4829)
- **M** Moisture Content (ASTM D 2216)
- **OC** Organic Content (ASTM D 2974)
- **P** Permeablility (ASTM D 2434)
- **PA** Particle Size Analysis (ASTM D 6913 [2002])
- **PI** Liquid Limit, Plastic Limit, Plasticity Index (ASTM D 4318)
- **PL** Point Load Index (ASTM D 5731)
- **PM** Pressure Meter
- **PP** Pocket Penetrometer
- **R** R-Value (CTM 301)
- **SE** Sand Equivalent (ASTM D 2419)
- **SG** Specific Gravity (ASTM D 854)
- **SW** Swell Potential (ASTM D 4546)
- **TV** Pocket Torvane
- **UC** Unconfined Compression - Soil (ASTM D 2166)
  Unconfined Compression - Rock (ASTM D 7012)
- **UU** Unconsolidated Undrained Triaxial (ASTM D 2850)
- **UW** Unit Weight (ASTM D 2937)

BORING LOG SYMBOLS

SAMPLE TYPE

- STANDARD PENETRATION TEST — Split barrel sampler in accordance with ASTM D-1586-84 Standard Test Method
- DRIVE SAMPLE — 2.42" I.D. sampler (CMS).
- DRIVE SAMPLE — No recovery
- BULK SAMPLE
- GROUNDWATER WHILE DRILLING
- GROUNDWATER AFTER DRILLING

DRILLING METHOD SYMBOLS

- Auger Drilling
- Mud Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

UNIFIED SOIL CLASSIFICATION AND KEY TO BORING LOG SYMBOLS

Converse Consultants

Mesa Lift Station Upgrades
Southeast of the intersection of Potrero Blvd. and Castello Ln.
City of Beaumont, Riverside County, California
For: Albert Webb Associates

Project No. 21-81-289-01

Drawing No. A-1a

Project ID: 21-81-213-01.GPX; Template: KEY

CONSISTENCY OF COHESIVE SOILS

Descriptor	Unconfined Compressive Strength (tsf)	SPT Blow Counts	Pocket Penetrometer (tsf)	CA Sampler	Torvane (tsf)	Field Approximation
Very Soft	<0.25	< 2	<0.25	<3	<0.12	Easily penetrated several inches by fist
Soft	0.25 - 0.50	2 - 4	0.25 - 0.50	3 - 6	0.12 - 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 - 1.0	5 - 8	0.50 - 1.0	7 - 12	0.25 - 0.50	Can be penetrated several inches by thumb with moderate effort
Stiff	1.0 - 2.0	9 - 15	1.0 - 2.0	13 - 25	0.50 - 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2.0 - 4.0	16 - 30	2.0 - 4.0	26 - 50	1.0 - 2.0	Readily indented by thumbnail
Hard	>4.0	>30	>4.0	>50	>2.0	Indented by thumbnail with difficulty

APPARENT DENSITY OF COHESIONLESS SOILS

Descriptor	SPT N_{60}- Value (blows / foot)	CA Sampler
Very Loose	<4	<5
Loose	4- 10	5 - 12
Medium Dense	11 - 30	13 - 35
Dense	31 - 50	36 - 60
Very Dense	>50	>60

MOISTURE

Descriptor	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OF PROPORTION OF SOILS

Descriptor	Criteria
Trace (fine)/ Scattered (coarse)	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

SOIL PARTICLE SIZE

Descriptor		Size
Boulder		> 12 inches
Cobble		3 to 12 inches
Gravel	Coarse	3/4 inch to 3 inches
	Fine	No. 4 Sieve to 3/4 inch
Sand	Coarse	No. 10 Sieve to No. 4 Sieve
	Medium	No. 40 Sieve to No. 10 Sieve
	Fine	No. 200 Sieve to No. No. 40 Sieve
Silt and Clay		Passing No. 200 Sieve

PLASTICITY OF FINE-GRAINED SOILS

Descriptor	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CEMENTATION/ Induration

Descriptor	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

NOTE: This legend sheet provides descriptions and associated criteria for required soil description components only. Refer to Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010), Section 2, for tables of additional soil description components and discussion of soil description and identification.

UNIFIED SOIL CLASSIFICATION AND KEY TO BORING LOG SYMBOLS

Log of Boring No. BH-01

Dates Drilled: 4/21/2022 Logged by: Mahmoud Suliman Checked By: Hashmi Quazi

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2424 Depth to Water (ft, bgs): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
0		**ALLUVIUM:** **SILTY SAND (SM):** fine to coarse-grained, very dense, few gravel up to 1" in maximum dimension, moist, brown.		X				CR, EI
			X	X	19/28/39	10	128	CL
5			X	X	19/36/44	9	132	C, DS CP, PA
		- tace clay	X	X	17/25/34	7	130	
10			X		25/30/33	9	121	
15			X		12/16/23	10	120	
20		**SILTY SAND WITH GRAVEL (SM):** fine to coarse-grained, very dense, some gravel up to 1" in maximum dimension, moist, brown.	X		6/11/17	10		PA
25			X		25/40/50-5"	9	134	
30			X		13/22/34	4		PA

Log of Boring No. BH-01

Dates Drilled: 4/21/2022 Logged by: Mahmoud Suliman Checked By: Hashmi Quazi

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2424 Depth to Water (ft, bgs): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM: **CLAYEY SAND (SC):** fine to medium-grained sand, very dense, moist, brown.	■		25/48/50-5"	9	106	
40		**SAND WITH SILT (SP-SM):** fine to coarse-grained, very dense, moist, yellowish brown.	☒		14/20/27	6		
45		**SILTY SAND (SM):** fine to coarse-grained, very dense, few gravel up to 1" in maximum dimension, moist, brown.	■		34/50-5"	22	85	
50			☒		11/17/27	17		
		End of boring at 51.5 feet bgs. No groundwater encountered. Borehole backfilled with soil cuttings mixed with cement, compacted by pushing down with augers using drill rig weight and the surface patched with cold asphalt on 4/21/2022.						

Log of Boring No. BH-02

Dates Drilled: 4/21/2022 Logged by: Mahmoud Suliman Checked By: Hashmi Quazi

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2424 Depth to Water (ft, bgs): NOT ENCOUNTERED

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Depth (ft)	Description	Samples: Drive	Samples: Bulk	Blows	Moisture (%)	Dry Unit Wt. (pcf)	Other
0	**ALLUVIUM:** **SILTY SAND (SM) (SM):** fine to coarse-grained, very dense, moist, reddish-brown.		X				CP, PA, R
		X	X	30/48/48	8	116	
5		X	X	17/25/41	10	126	
			X				CR
	- trace clay	X	X	17/25/42	11	126	DS
10	- few gravel up to 0.5" in maximum dimension	X		25/27/32	5	122	
15	- dense	X		18/20/29	8	126	
20	**SAND WITH SILT (SP-SM):** fine to coarse-grained, very dense, moist, yellowish brown.	X		50-5"			dist.

End of boring at 21.5 feet bgs.
No groundwater encountered.
Borehole backfilled with soil cuttings mixed with cement, compacted by pushing down with augers using drill rig weight and the surface patched with cold asphalt on 4/21/2022.

Appendix B

Laboratory Testing Program

APPENDIX B

LABORATORY TESTING PROGRAM

Tests were conducted in our laboratory on representative soil samples for the purpose of classification and evaluation of their physical properties and engineering characteristics. The amount and selection of tests were based on the geotechnical parameters required for this project. Test results are presented herein and on the Logs of Borings, in Appendix A, *Field Exploration*. The following is a summary of the various laboratory tests conducted for this project.

In-Situ **Moisture Content and Dry Density**

In-situ dry density and moisture content tests were performed on relatively undisturbed ring samples, in accordance with ASTM Standard D2216 and D2937 to aid soils classification and to provide qualitative information on strength and compressibility characteristics of the site soils. For test results, see the Logs of Borings in Appendix A, *Field Exploration.*

Expansion Index

Two representative bulk samples were tested to evaluate the expansion potential in accordance with ASTM Standard D4829. The test results are presented in the following table.

Table No. B-1, Expansion Index Test Result

Boring No.	Depth (feet)	Soil Description	Expansion Index	Expansion Potential
BH-01	0-5	Silty Sand (SM)	0	Very Low
BH-02	0-5	Silty Sand (SM)	16	Very Low

R-value

One representative bulk soil sample was performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with California Test Method CT301 for resistance value (R-value). The test provides a relative measure of soil strength for use in pavement design. The test results are presented in the following table.

Table No. B-2, R-Value Test Results

Boring No.	Depth (feet)	Soil Classification	Measured R-value
BH-02	0-5	Silty Sand (SM)	36

Soil Corrosivity

Two representative soil samples were tested to determine minimum electrical resistivity, pH, and chemical content, including soluble sulfate and chloride concentrations. The purpose of these tests was to determine the corrosion potential of site soils when placed in contact with common construction materials. The tests were performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with Caltrans Test Methods 643, 422 and 417. Test results are presented in the following table.

Table No. B-3, Summary of Soil Corrosivity Test Results

Boring No.	Depth (feet)	pH	Soluble Sulfates (CA 417) (ppm)	Soluble Chlorides (CA 422) (ppm)	Min. Resistivity (CA 643) (Ohm-cm)
BH-01	0-5	8.5	39	21	4,093
BH-02	5-10	8.7	32	20	4,232

Collapse

To evaluate the moisture sensitivity (collapse/swell potential) of the encountered soils, two collapse tests were performed in accordance with the ASTM Standard D4546 laboratory procedure. The samples were loaded to approximately 2 kips per square foot (ksf), allowed to stabilize under load, and then submerged. The tests results are presented in the following table.

Table No. B-4, Collapse Test Results

Boring No.	Depth (ft)	Soil Classification	Percent Swell (+) Percent Collapse (-)	Collapse Potential
BH-01	2.5-4.0	Silty Sand (SM)	-0.7	Slight
BH-01	5.0-6.5	Silty Sand (SM)	-1.0	Slight

Grain-Size Analysis

To assist in classification of soils, mechanical grain-size analyses were performed on four select samples in accordance with the ASTM Standard D6913 test method. Grain-size curves are shown in Drawing No. B-1, *Grain Size Distribution Results* and results are presented in the below table.

Table No. B-5, Grain Size Distribution Test Results

Boring No.	Depth (ft)	Soil Classification	% Gravel	% Sand	%Silt	%Clay
BH-01	5-10	Silty Sand (SM)	9.0	63.5	27.5	
BH-01	20.0-21.5	Silty Sand with Gravel (SM)	21.0	54.2	24.8	
BH-01	30.0-31.5	Silty Sand with Gravel (SM)	15.0	69.6	15.4	
BH-02	0-5	Silty Sand (SM)	12.0	59.3	28.7	

Maximum Density and Optimum Moisture Content

Laboratory maximum dry density-optimum moisture content relationship tests were performed on two representative bulk samples. The tests were conducted in accordance with the ASTM Standard D1557 test method. The tests results are presented in Drawing No. B-2, *Moisture-Density Relationship Results,* and are summarized in the following table.

Table No B-6, Summary of Moisture-Density Relationship Results

Boring No.	Depth (ft)	Soil Description	Optimum Moisture (%)	Maximum Density (lb./cft)
BH-01	5-10	Silty Sand (SM), Yellowish Brown	9.2	133.5
BH-02	0-5	Silty Sand (SM), Yellowish Brown	9.0	129.0

Direct Shear

Two direct shear tests were performed on relatively undisturbed representative ring samples under soaked moisture condition in accordance with the ASTM D3080 procedure. For the test, three samples contained in brass sampler rings were placed, one at a time, directly into the test apparatus and subjected to a range of normal loads appropriate for the anticipated conditions. The samples were then sheared at a constant strain rate of 0.02 inch/minute. Shear deformation was recorded until a maximum of about 0.25-inch shear displacement was achieved. Ultimate strength was selected from the shear-stress deformation data and plotted to determine the shear strength parameters. For test data, including sample density and moisture content, see Drawings No. B-3 and B-4*, Direct Shear Test Results,* and the following table.

Table No. B-7, Summary of Direct Shear Test Results

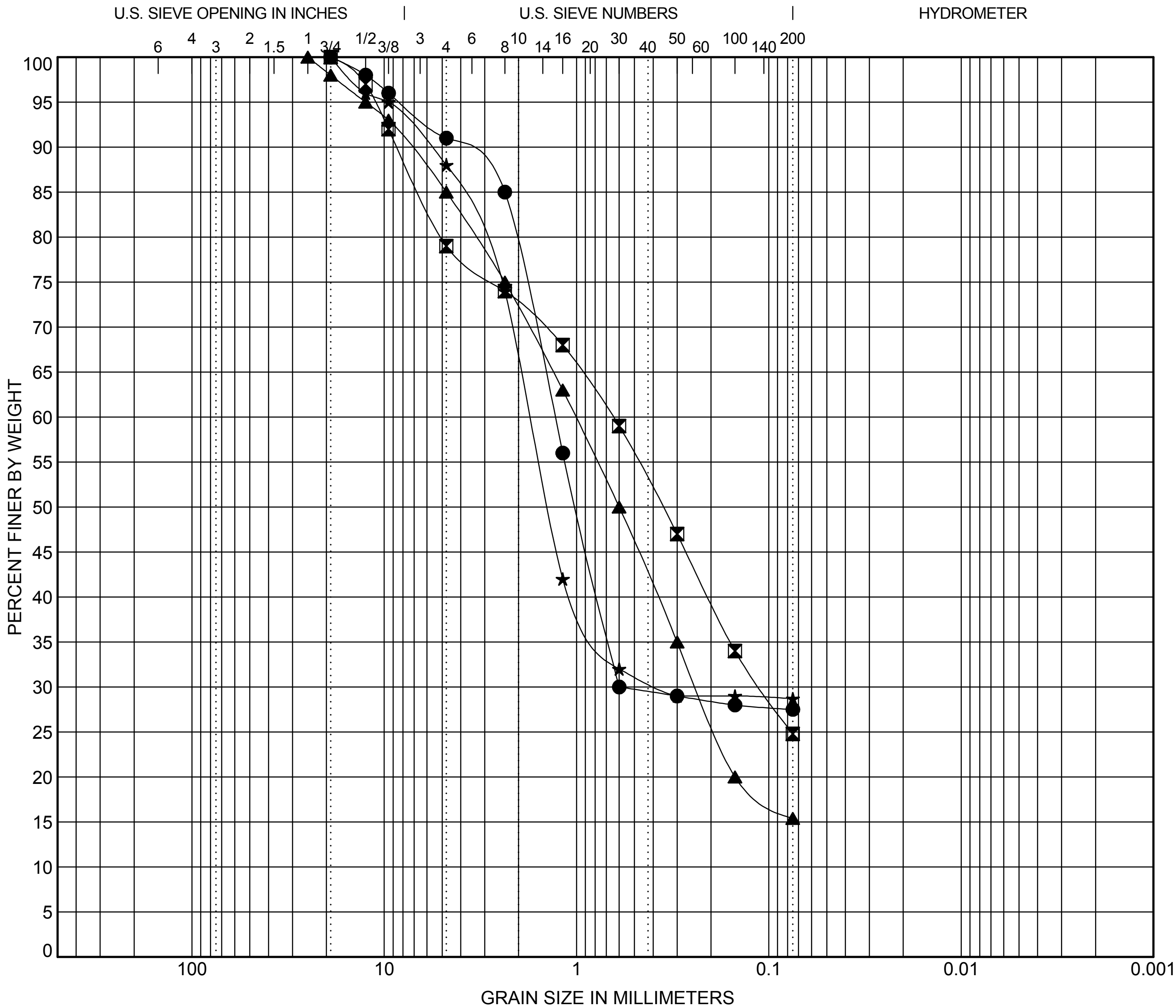
Boring No.	Depth (feet)	Soil Description	Peak Strength Parameters	
			Friction Angle (degrees)	Cohesion (psf)
BH-01	5.0-6.5	Silty Sand (SM)	33	80
BH-02	7.5-9.0	Silty Sand (SM)	34	20

Consolidation

One test was conducted in accordance with ASTM Standard D2435 method. Data obtained from this test on a relatively undisturbed ring sample was used to evaluate the settlement characteristics of the on-site soils under load. Preparation for this test involved trimming the sample, placing it in a 1-inch-high brass ring, and loading it into the test apparatus, which contained porous stones to accommodate drainage during testing. Normal axial loads were applied to one end of the sample through the porous stones, and the resulting deflections were recorded at various time periods. The load was increased after the sample reached a reasonable state of equilibrium. Normal loads were applied at a constant load-increment ratio, successive loads being generally twice the preceding load. For test result, including sample density and moisture content, see Drawing No. B-5 *Consolidation Test Result*.

Sample Storage

Soil samples presently stored in our laboratory will be discarded 30 days after the date of this report, unless this office receives a specific request to retain the samples for a longer period.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	**BH-01**	**5-10**	**SILTY SAND (SM)**					
⊠	**BH-01**	**20-21.5**	**SILTY SAND WITH GRAVEL (SM)**					
▲	**BH-01**	**30.0-31.5**	**SILTY SAND WITH GRAVEL (SM)**					
★	**BH-02**	**5-10**	**SILTY SAND (SM)**					

	Boring No.	Depth (ft)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-01**	**5-10**	**19**	**1.298**	**0.6**		**9.0**	**63.5**	**27.5**	
⊠	**BH-01**	**20-21.5**	**19**	**0.647**	**0.111**		**21.0**	**54.2**	**24.8**	
▲	**BH-01**	**30.0-31.5**	**25**	**1.009**	**0.238**		**15.0**	**69.6**	**15.4**	
★	**BH-02**	**5-10**	**19**	**1.743**	**0.378**		**12.0**	**59.3**	**28.7**	

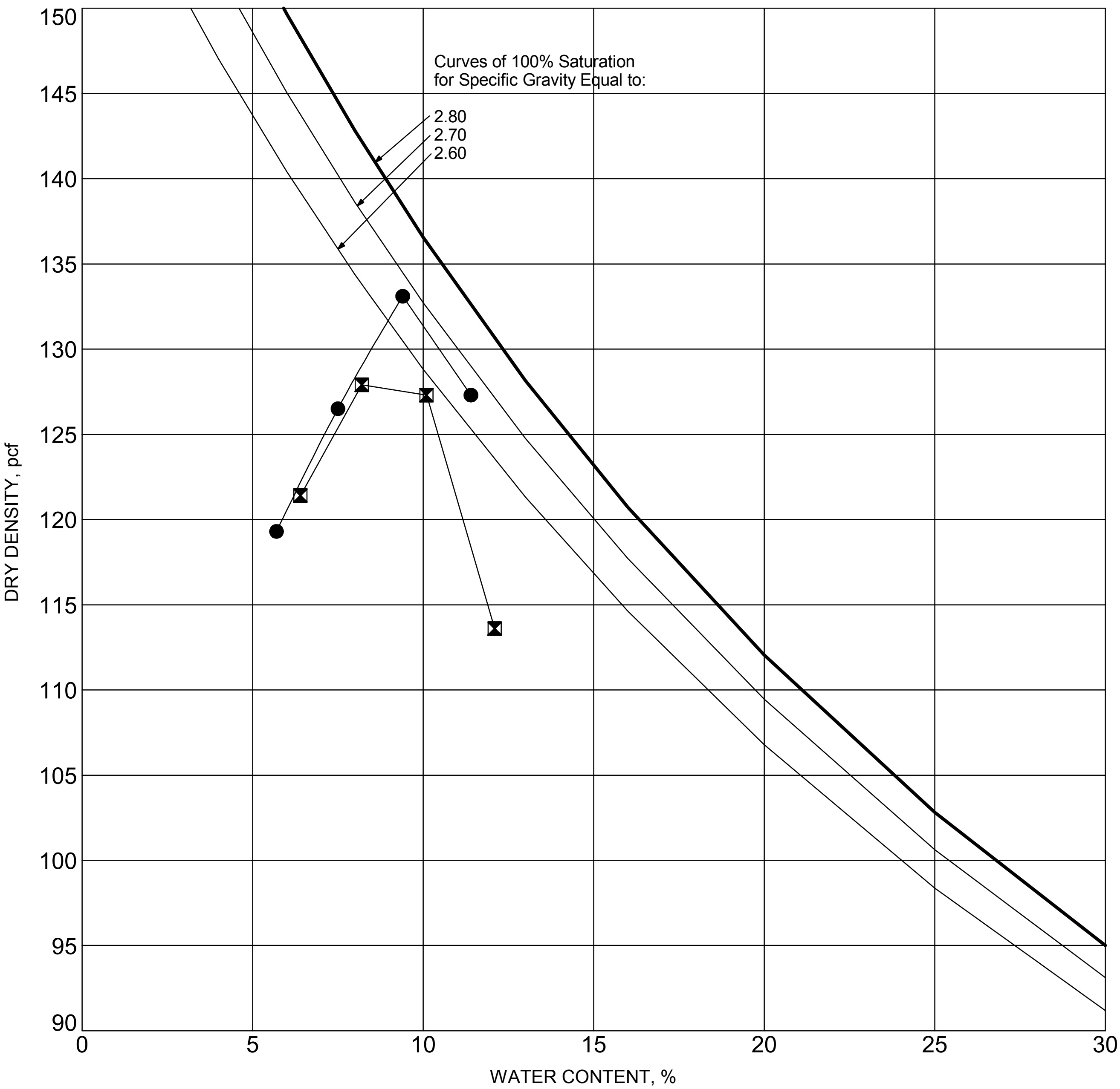
GRAIN SIZE DISTRIBUTION RESULTS

Converse Consultants

Mesa Lift Station Upgrades
Southeast of the intersection of Potrero Blvd. and Castello Ln.
City of Beaumont, Riverside County, California
For: Albert Webb Associates

Project No. **21-81-289-01**

Drawing No. **B-1**



SYMBOL	BORING NO.	DEPTH (ft)	DESCRIPTION	ASTM TEST METHOD	OPTIMUM WATER, %	MAXIMUM DRY DENSITY, pcf
●	**BH-01**	**5-10**	**SILTY SAND (SM), BROWN**		**9.2**	**133.5**
⧗	**BH-02**	**0-5**	**SILTY SAND (SM), REDDISH BROWN**		**9.0**	**129.0**

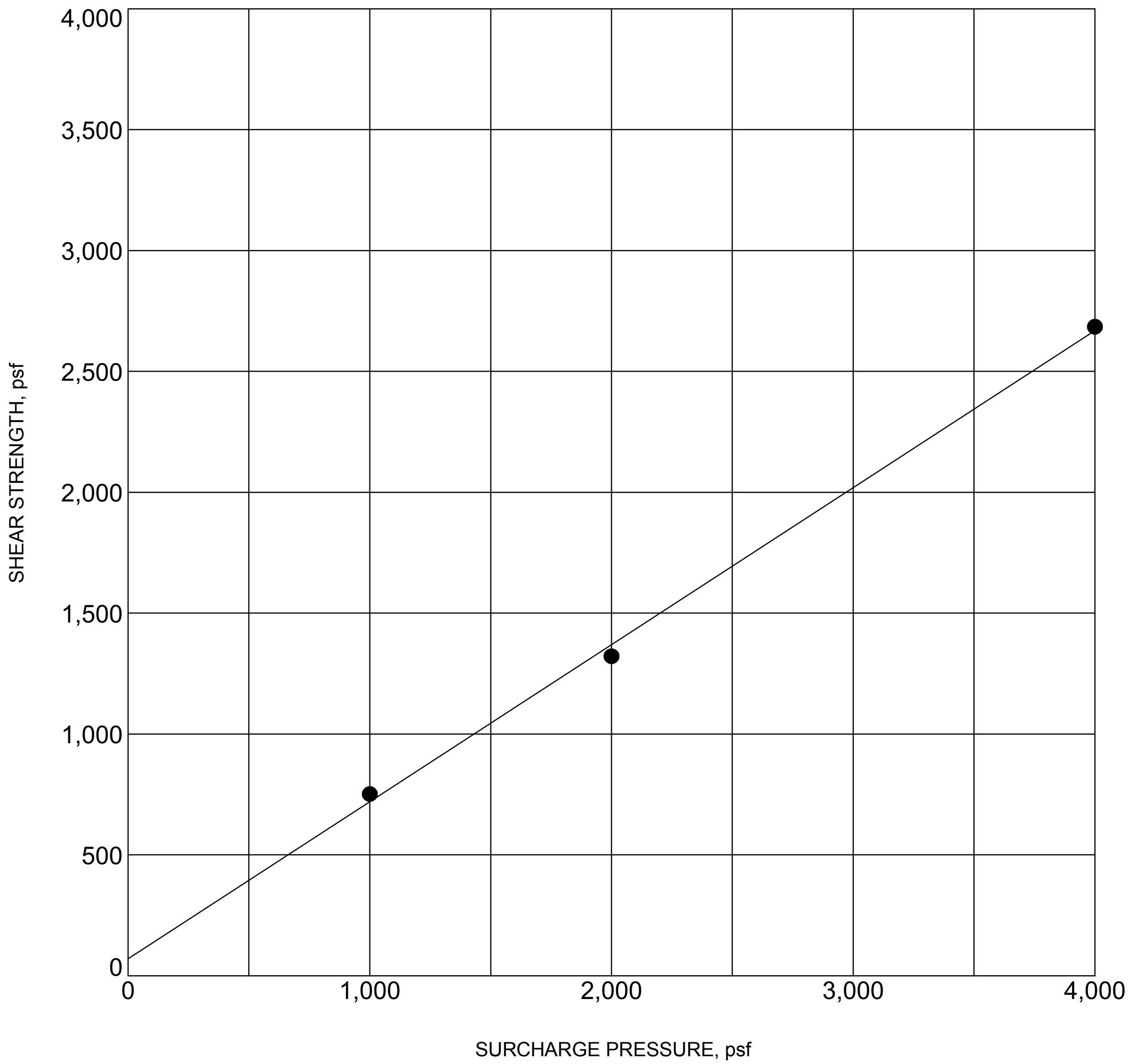
MOISTURE-DENSITY RELATIONSHIP RESULTS

Converse Consultants

Mesa Lift Station Upgrades
Southeast of the intersection of Potrero Blvd. and Castello Ln.
City of Beaumont, Riverside County, California
For: Albert Webb Associates

Project No. **21-81-289-01**

Drawing No. **B-2**



BORING NO. :	BH-01	DEPTH (ft) :	5.0-6.5
DESCRIPTION :	SILTY SAND (SM)		
COHESION (psf) :	70	FRICTION ANGLE (degrees):	33
MOISTURE CONTENT (%) :	9.0	DRY DENSITY (pcf) :	132.5

NOTE: Ultimate Strength.

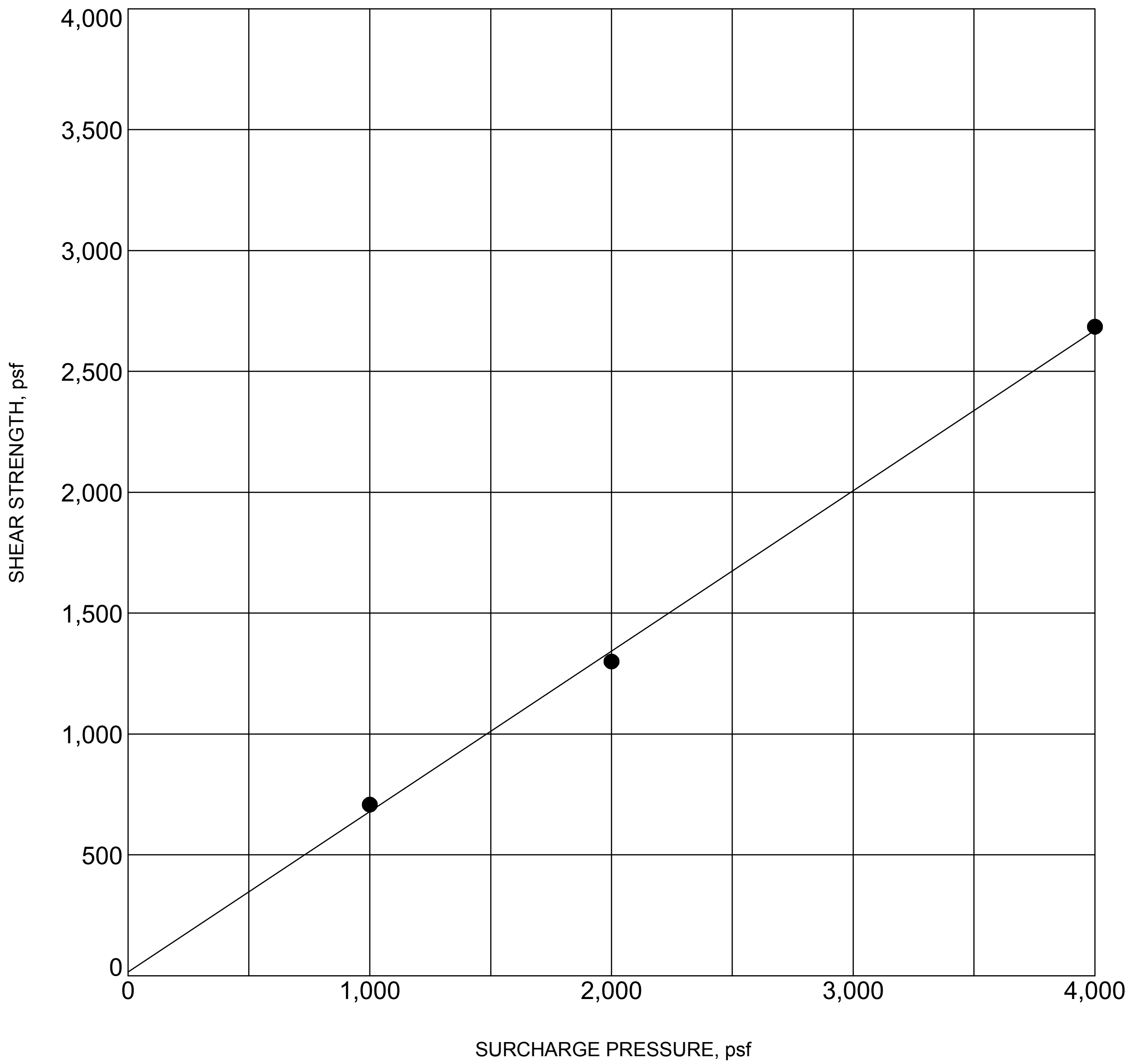
DIRECT SHEAR TEST RESULTS

Converse Consultants

Mesa Lift Station Upgrades
Southeast of the intersection of Potrero Blvd. and Castello Ln.
City of Beaumont, Riverside County, California
For: Albert Webb Associates

Project No. **21-81-289-01**

Drawing No. **B-3**



BORING NO. :	**BH-02**	DEPTH (ft) :	**7.5-9.0**
DESCRIPTION :	**SILTY SAND (SM)**		
COHESION (psf) :	**20**	FRICTION ANGLE (degrees):	**34**
MOISTURE CONTENT (%) :	**11.0**	DRY DENSITY (pcf) :	**126.4**

NOTE: Ultimate Strength.

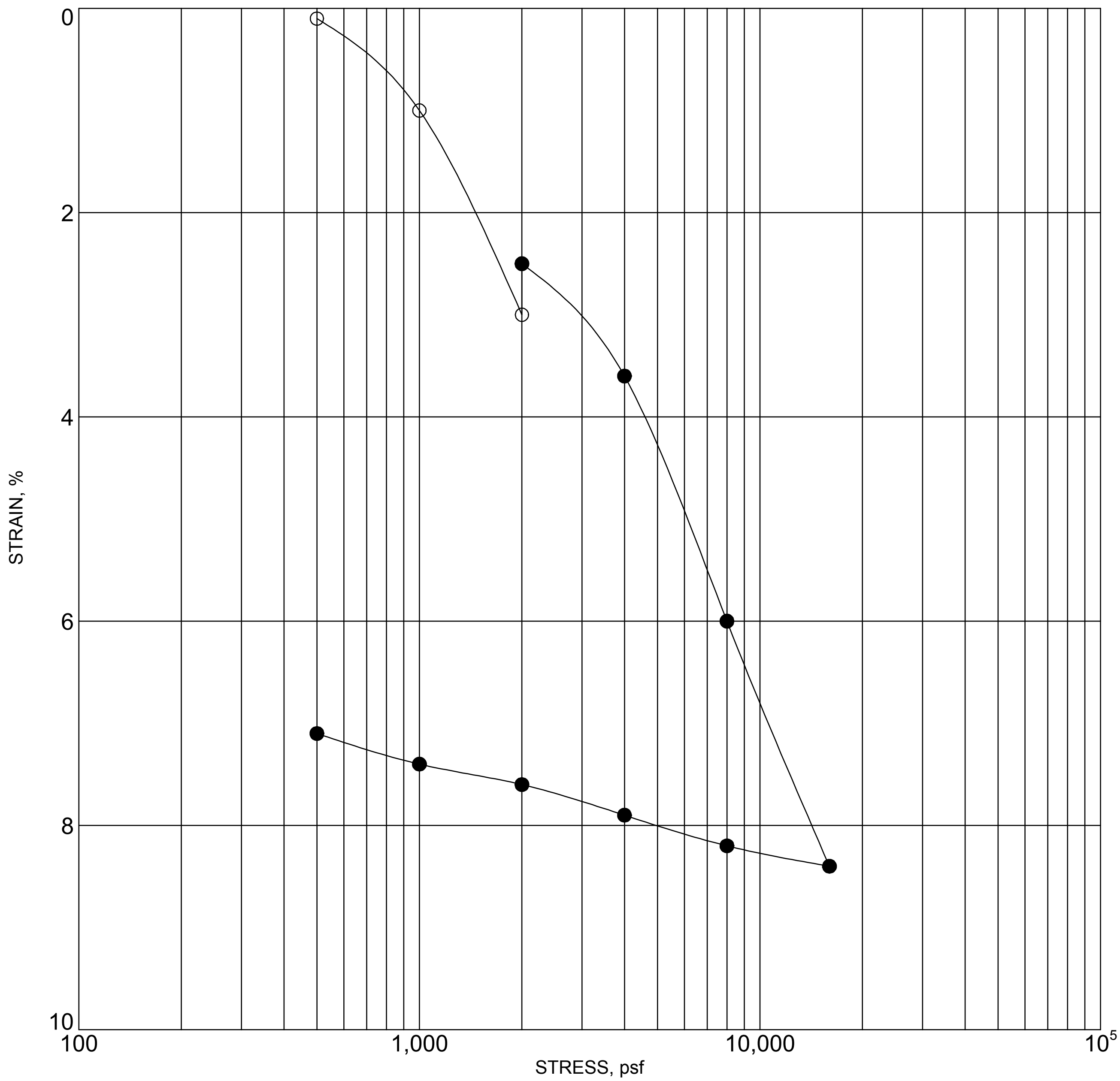
DIRECT SHEAR TEST RESULTS

Converse Consultants

Mesa Lift Station Upgrades
Southeast of the intersection of Potrero Blvd. and Castello Ln.
City of Beaumont, Riverside County, California
For: Albert Webb Associates

Project No. **21-81-289-01**

Drawing No. **B-4**



BORING NO. :	BH-01	DEPTH (ft) :	5.0-6.5
DESCRIPTION :	SILTY SAND (SM)		

	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	PERCENT SATURATION	VOID RATIO
INITIAL	9	132	94	0.251

NOTE: SOLID CIRCLES INDICATE READINGS AFTER ADDITION OF WATER

CONSOLIDATION TEST RESULTS

Converse Consultants

Mesa Lift Station Upgrades
Southeast of the intersection of Potrero Blvd. and Castello Ln.
City of Beaumont, Riverside County, California
For: Albert Webb Associates

Project No. **21-81-289-01**

Drawing No. **B-5**

Appendix C

Liquefaction & Seismic Settlement Analysis

APPENDIX C

LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSIS

The subsurface data obtained from the boring BH-02 was used to evaluate the liquefaction potential and associated dry seismic settlement when subjected to ground shaking during earthquakes.

A simplified liquefaction hazard analysis was performed using the program SPTLIQ (InfraGEO Software, 2020) using the liquefaction triggering analysis method by Boulanger and Idriss (2014). A modal earthquake magnitude of M 8.1 was selected based on the results of seismic deaggregation analysis using the USGS interactive online tool (https://earthquake.usgs.gov/hazards/interactive/).

A peak ground acceleration (PGA_M) of 0.74g for the MCE design event, where g is the acceleration due to gravity, was selected for this analysis. The PGA was based on the 2019 CBC seismic design parameters presented in Section 7.3.2, *Site-Specific Seismic Design Parameters.* The result of our analysis is presented on Sheet Nos. C-1 through C-3 and summarized in the following table.

Table C-1, Estimated Dynamic Settlements

Location	Groundwater Conditions	Groundwater Depth (feet bgs)	Dry Seismic Settlement (inches)	Liquefaction Induced Settlement (inches)
BH-01	Current	>50	0.4	Negligible
	Historical	>50		

Based on our analysis, the potential for liquefaction induced settlement is negligible and dry seismic settlement is up to 0.4 inches.

The soil profile across the site is relatively similar. So, we anticipate that the total dynamic settlement will be uniform. We recommend that the planned structure be designed conservatively in anticipation of dynamic differential settlement of 0.5 inch in 40 horizontal feet.

SIMPLIFIED LIQUEFACTION HAZARDS ASSESSMENT USING STANDARD PENETRATION TEST (SPT) DATA

(Copyright © 2015, 2019, SPTLIQ, All Rights Reserved; By: InfraGEO Software)

PROJECT INFORMATION

Project Name	Mesa Lift Station Project
Project No.	21-81-289-01
Project Location	City of Beaumont, Riverside County, California
Analyzed By	Mahmoud Suliman
Reviewed By	Hashmi Quzai

SELECTED METHODS OF ANALYSIS

Analysis Description	
Triggering of Liquefaction	Boulanger-Idriss (2014)
Severity of Liquefaction	LPI: Liquefaction Potential Index based on Iwasaki et al. (1978)
Seismic Compression Settlement (Dry/Unsaturated Soil)	Pradel (1998)
Liquefaction-Induced Settlement (Saturated Soil)	Ishihara and Yoshimine (1992)
Liquefaction-Induced Lateral Spreading	Zhang et al. (2004)
Residual Shear Strength of Liquefied Soil	Idriss and Boulanger (2008)

SEISMIC DESIGN PARAMETERS

Earthquake Moment Magnitude, M_w	8.10	
Peak Ground Acceleration, A_{max}	0.76	g
Factor of Safety Against Liquefaction, FS	1.20	

BORING DATA AND SITE CONDITIONS

Boring No.	BH-01	
Ground Surface Elevation	2424.00	feet
Proposed Grade Elevation	2424.00	feet
GWL Depth Measured During Test	52.00	feet
GWL Depth Used in Design	52.00	feet
Borehole Diameter	8.00	inches
Hammer Weight	140.00	pounds
Hammer Drop	30.00	inches
Hammer Energy Efficiency Ratio, ER (%)	80.00	%
Hammer Distance to Ground Surface	5.00	feet
Topographic Site Condition:	TSC1	(Level Ground with No Nearby Free Face)
- Ground Slope, S (%)		<<= Leave this blank
- Free Face Distance to Slope Height Ratio, (L/H)		<<= Leave this blank Set H to zero =>> 0.00 feet

INPUT SOIL PROFILE DATA

Depth to Top of Soil Layer (feet)	Depth to Bottom of Soil Layer (feet)	Material Type USCS Group Symbol (ASTM D2487)	Liquefaction Screening *Susceptible Soil? (Y, N)*	Total Soil Unit Weight γ_t (pcf)	Field SPT Blow Count N_{field} (blows/ft)	Type of Soil Sampler	Fines Content FC (%)
0.00	5.00	SM	Y	140.0	43.0	SPT1	15.00
5.00	10.00	SM	Y	139.0	50.0	SPT1	15.00
10.00	15.00	SM	Y	131.0	41.0	SPT1	15.00
15.00	20.00	SM	Y	132.0	25.0	SPT1	15.00
20.00	25.00	SM	Y	145.0	28.0	SPT1	12.00
25.00	30.00	SP-SM	Y	145.0	32.5	SPT1	12.00
30.00	35.00	SM	Y	118.0	28.0	SPT1	15.00
35.00	40.00	SC	Y	118.0	50.0	SPT1	15.00
40.00	45.00	SP-SM	Y	103.0	47.0	SPT1	12.00
45.00	50.00	SM	Y	103.0	44.0	SPT1	25.00

SIMPLIFIED LIQUEFACTION HAZARDS ASSESSMENT USING STANDARD PENETRATION TEST (SPT) DATA

(Copyright © 2015, 2019, SPTLIQ, All Rights Reserved; By: InfraGEO Software)

PROJECT INFORMATION

Project Name	Mesa Lift Station Project
Project No.	21-81-289-01
Project Location	City of Beaumont, Riverside County, California
Analyzed By	Mahmoud Suliman
Reviewed By	Hashmi Quzai

SEISMIC DESIGN PARAMETERS

Earthquake Moment Magnitude, M_w	8.10
Peak Ground Acceleration, A_{max}	0.76 g
Factor of Safety Against Liquefaction, FS	1.20

BORING DATA AND SITE CONDITIONS

Boring No.	BH-01
Ground Surface Elevation	2424.00 feet
Proposed Grade Elevation	2424.00 feet
GWL Depth Measured During Test	52.00 feet
GWL Depth Used in Design	52.00 feet
Borehole Diameter	8.00 inches
Hammer Weight	140.00 pounds
Hammer Drop	30.00 inches
Hammer Energy Efficiency Ratio, ER	80.00 %
Hammer Distance to Ground Surface	5.00 feet
Topographic Site Condition:	TSC1 (Level Ground with No Nearby Free Face)
- Ground Slope, S	0.00 %
- Free Face (L/H) Ratio	N/A H = 0 feet
Average Total Unit Weight of New Fill	120.00 pcf (assumed)

SUMMARY OF RESULTS

Severity of Liquefaction:

Total Thickness of Liquefiable Soils: 0.00 feet (cumulative total thickness in the upper 65 feet)

Liquefaction Potential Index (LPI): 0.00 *** (Very low risk, with no surface manifestation of liquefaction)

Seismic Ground Settlements:

	Analysis Method	Upper 30 feet	Upper 50 feet	Upper 65 feet	
Seismic Compression Settlement:	Pradel (1998)	0.25 inches	0.40 inches	0.40 inches	(Dry/Unsaturated Soils)
Liquefaction-Induced Settlement:	Ishihara and Yoshimine (1992)	0.00 inches	0.00 inches	0.00 inches	(Saturated Soils)
Total Seismic Settlement:		0.25 inches	0.40 inches	0.40 inches	

Seismic Lateral Displacements:

	Analysis Method	Upper 30 feet	Upper 50 feet	Upper 65 feet	
Cyclic Lateral Displacement:	Tokimatsu and Asaka (1998)	0.22 inches	0.35 inches	0.35 inches	(During Ground Shaking)
Lateral Spreading Displacement:	Zhang et al. (2004)	0.00 inches	0.00 inches	0.00 inches	(After Ground Shaking)

NOTES AND REFERENCES

\+ This method of analysis is based on observed seismic performance of level ground sites using correlation with normalized and fines-corrected SPT blow count, $(N_1)_{60cs} = f\{(N_1)_{60}, FC\}$ where $(N_1)_{60} = N_{field}\, C_N\, C_E\, C_B\, C_R\, C_S$

++ Liquefaction susceptibility screening is performed to identify soil layers assessed to be non-liquefiable based on laboratory test results using the criteria proposed by Cetin and Seed (2003), Bray and Sancio (2006), or Idriss and Boulanger (2008).

* FS_{liq} = Factor of Safety against liquefaction = (CRR/CSR), where $CRR = CRR_{7.5}\ MSF\ K_\sigma\ K_\alpha$, MSF = Magnitude Scaling Factor, $K_\sigma = f[(N_1)_{60}, \sigma'_{vo}]$, K_α =1.0, (level ground),

CSR = Cyclic Stress Ratio = $0.65\ A_{max}\ (\sigma_{vo}/\sigma'_{vo})\ r_d$, and $CRR_{7.5}$ = Cyclic Resistance Ratio is a function of $(N_1)_{60cs}$ and corrected for an earthquake magnitude M_w of 7.5.

** Residual strength values of liquefied soils are based on correlation with post-earthquake, normalized and fines-corrected SPT blow count derived by Idriss and Boulanger (2008).

*** Based on Iwasaki et al. (1978) and Toprak and Holzer (2003)

\+ Reference: Boulanger, R.W. and Idriss, I.M. (2014), "CPT and SPT Based Liquefaction Triggering Procedures," University of California Davis, Center for Geotechnical Modeling Report No. UCD/CGM-14/01, 1-134.

INPUT SOIL PROFILE DATA / LIQUEFACTION TRIGGERING ANALYSIS BASED ON R.W. BOULANGER AND I.M. IDRISS (2014) METHOD +

Depth to Top of Soil Layer (feet)	Depth to Bottom of Soil Layer (feet)	Material Type USCS Group Symbol (ASTM D2487)	Liquefaction Susceptibility Screening ++ Susceptible Soil? (Y/N)	Total Soil Unit Weight γ_t (pcf)	Field SPT Blow Count N_{field} (blows/ft)	Type of Soil Sampler	Fines Content FC (%)	Total Vert. Stress (Design) σ_{vo} (psf)	Effective Vert. Stress (Design) σ'_{vo} (psf)	SPT Corr. for Vert. Stress C_N	SPT Corr. for Hammer Energy C_E	SPT Corr. for Borehole Size C_B	SPT Corr. for Rod Length C_R	SPT Corr. for Sampling Method C_S
0.00	5.00	SM	Y	140.00	43.00	SPT1	15.00	350.00	350.00	1.326	1.333	1.150	0.750	1.000
5.00	10.00	SM	Y	139.00	50.00	SPT1	15.00	1,047.50	1,047.50	1.103	1.333	1.150	0.800	1.000
10.00	15.00	SM	Y	131.00	41.00	SPT1	15.00	1,722.50	1,722.50	1.032	1.333	1.150	0.850	1.000
15.00	20.00	SM	Y	132.00	25.00	SPT1	15.00	2,380.00	2,380.00	0.944	1.333	1.150	0.950	1.000
20.00	25.00	SM	Y	145.00	28.00	SPT1	12.00	3,072.50	3,072.50	0.869	1.333	1.150	0.950	1.000
25.00	30.00	SP-SM	Y	145.00	32.50	SPT1	12.00	3,797.50	3,797.50	0.822	1.333	1.150	0.950	1.000
30.00	35.00	SM	Y	118.00	28.00	SPT1	15.00	4,455.00	4,455.00	0.758	1.333	1.150	1.000	1.000
35.00	40.00	SC	Y	118.00	50.00	SPT1	15.00	5,045.00	5,045.00	0.863	1.333	1.150	1.000	1.000
40.00	45.00	SP-SM	Y	103.00	47.00	SPT1	12.00	5,597.50	5,597.50	0.819	1.333	1.150	1.000	1.000
45.00	50.00	SM	Y	103.00	44.00	SPT1	25.00	6,112.50	6,112.50	0.774	1.333	1.150	1.000	1.000

Depth to Top of Soil Layer (feet)	Depth to Bottom of Soil Layer (feet)	Corrected SPT Blow Count N_{60}	Normalized SPT Blow Count $(N_1)_{60}$	Fines Corrected SPT Blow Count $(N_1)_{60cs}$	Shear Stress Reduction Coefficient r_d	Correction for High Overburden Stress K_σ	Cyclic Stress Ratio CSR	Cyclic Resistance Ratio CRR	Factor of Safety * FS_{liq}	Liquefaction Analysis Results	Residual Shear Strength ** S_r (psf)	Seismic Porewater Pressure Ratio r_u (%)	Cumulative Seismic Settlement (inches)	Cumulative Cyclic Lateral Displacement (inches)	Cumulative Lateral Spreading Displacement (inches)
0.00	5.00	49.5	65.5	68.8	1.000	1.100	0.494						0.40	0.35	0.00
5.00	10.00	61.3	67.7	70.9	0.995	1.100	0.492						0.40	0.35	0.00
10.00	15.00	53.4	55.2	58.4	0.986	1.045	0.487						0.40	0.35	0.00
15.00	20.00	36.4	34.4	37.6	0.976	0.956	0.482						0.40	0.35	0.00
20.00	25.00	40.8	35.4	37.5	0.965	0.871	0.477						0.27	0.24	0.00
25.00	30.00	47.3	38.9	41.0	0.952	0.808	0.470						0.15	0.13	0.00
30.00	35.00	42.9	32.5	35.8	0.939	0.816	0.464						0.15	0.13	0.00
35.00	40.00	76.7	66.2	69.4	0.925	0.722	0.457						0.00	0.00	0.00
40.00	45.00	72.1	59.0	61.1	0.909	0.691	0.449						0.00	0.00	0.00
45.00	50.00	67.5	52.2	57.3	0.894	0.665	0.441						0.00	0.00	0.00

REFERENCES:

1. Boulanger, R.W. and Idriss, I.M. (2014), "CPT and SPT Based Liquefaction Triggering Procedures," University of California Davis, Center for Geotechnical Modeling Report No. UCD/CGM-14/01, 1-134.
2. Bray, J.D., and Sancio, R.B. (2006). "Assessment of the liquefaction susceptibility of fine-grained soils," Journal of Geotechnical and Geoenvironmental Engineering, ASCE 132 (9), 1165-1177.
3. Cetin, K.O. and Seed, R.B., et al. (2004), "Standard penetration test-based probabilistic and deterministic assessment of seismic soil liquefaction potential," Journal of Geotechnical and Geoenvironmental Engineering, ASCE 130 (12), 1314-1340.
4. Idriss, I.M. and Boulanger, R.W. (2008), "Soil Liquefaction During Earthquakes", Earthquake Engineering Research Institute (EERI), Monograph MNO-12.
5. Ishihara, K. and Yoshimine, M. (1992), "Evaluation of settlements in sand deposits following liquefaction during earthquakes," Soils and Foundations, Japanese Geotechnical Society, 32 (1), 173-188.
6. Iwasaki, T., et al. (1978), "A practical method for assessing soil liquefaction potential based on case studies at various sites in Japan," Proceedings Of 3rd International Conference of Microzonation, San Francisco, 885-896.
7. Olson, S.M. and Johnson, C.I. (2008), "Analyzing Liquefaction-Induced Lateral Spreads Using Strength Ratios," Journal of Geotechnical and Geoenvironmental Engineering, ASCE 134 (8), 1035-1049.
8. Pradel, D. (1998), "Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils," Journal of Geotechnical Engineering, ASCE 124 (4), pp. 364-368.
9. Seed, R.B. and Harder, L.F. (1990), "SPT-based analysis of cyclic pore pressure generation and undrained residual strength, Proceedings Of Seed Memorial Symposium, Vancouver, B.C., 351-376.
10. Tokimatsu, K. and Seed, H.B. (1987), "Evaluation of settlements in sands due to earthquake shaking," Journal of Geotechnical Engineering, ASCE 113 (GT8), 861-878.
11. Tokimatsu, K. and Asaka, Y. (1998), "Effects of liquefaction-induced ground displacementson pile performance in the 1995 Hyogoken-Nambu Earthquake," Soils and Foundations, Special Issue, Japan Geotechnical Society, 163-177.
12. Tonkin & Taylor (2013), "Liquefaction Vulnerability Study," Report prepared for the Earthquake Commission (EQC), February, T&T Report No. 520.20.0200.
13. Toprak, S. and Holzer, T.L. (2003), "Liquefaction Potential Index: Field Assessment," Journal of Geotechnical and Geoenviromental Engineering, ASCE 129 (4), 315-322.
14. Youd, T.L, Idriss, I.M., et al. (2001), "Liquefaction resistance of soils: summary report from the 1996 NCEER and 1998 NCEER/NSF Workshops", Journal of Geotechnical and Geoenvironmental Engineering, ASCE 127 (10), 817-833.
15. Zhang, G, Robertson, P.K. and Brachman, R.W.I. (2004), "Estimating liquefaction-induced lateral displacement using the standard penetration test or cone penetration test," Journal of Geotechnical and Geoenvironmental Engineering, ASCE 130 (8), 861-871.

SIMPLIFIED LIQUEFACTION HAZARDS ASSESSMENT USING STANDARD PENETRATION TEST (SPT) DATA

(Copyright © 2015, 2019, SPTLIQ, All Rights Reserved; By: InfraGEO Software)

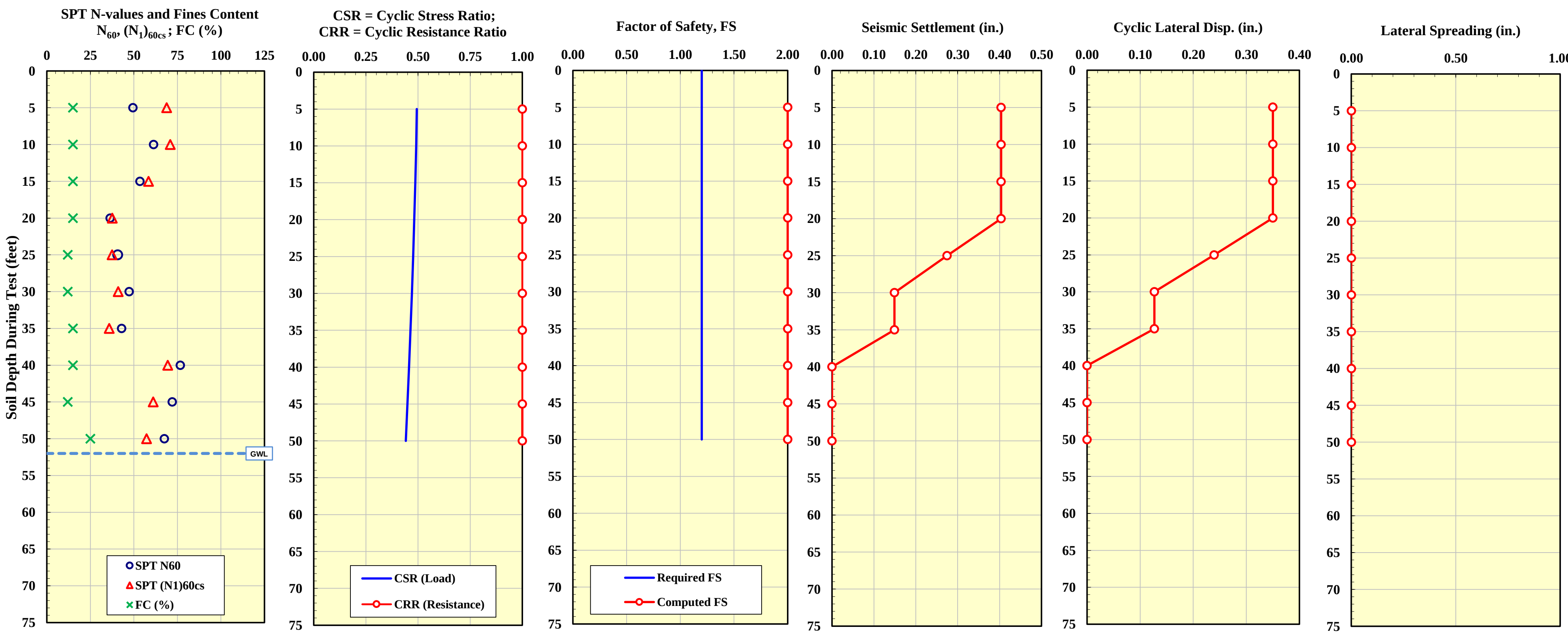
PROJECT INFORMATION	
Project Name	Mesa Lift Station Project
Project No.	21-81-289-01
Project Location	City of Beaumont, Riverside County, California
Analyzed By	Mahmoud Suliman
Reviewed By	Hashmi Quzai

TOPOGRAPHIC CONDITIONS		
Ground Slope, S	0.00 %	
Free Face (L/H) Ratio	N/A	H = 0.00 feet

GROUNDWATER DATA	
GWL Depth Measured During Test	52.00 feet
GWL Depth Used in Design	52.00 feet

BORING DATA	
Boring No.	BH-01
Ground Surface Elevation	2424.00 feet
Proposed Grade Elevation	2424.00 feet
Borehole Diameter	8.00 inches
Hammer Weight	140.00 pounds
Hammer Drop	30.00 inches
Hammer Energy Efficiency Ratio, ER	80.00 %
Hammer Distance to Ground Surface	5.00 feet

SEISMIC DESIGN PARAMETERS	
Earthquake Moment Magnitude, M_w	8.10
Peak Ground Acceleration, A_{max}	0.76 g
Factor of Safety Against Liquefaction, FS	1.20



Analysis Methods Used ==>>

Liquefaction Triggering:

Boulanger-Idriss (2014)

Seismic Settlements:

Above GWL: Pradel (1998)
Below GWL: Ishihara and Yoshimine (1992)

Cyclic Lateral Displacements:

Above GWL: Pradel (1998)
Below GWL: Tokimatsu and Asaka (1998)

Lateral Spreading:

Zhang et al. (2004)

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold milling of existing asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt overlay.
5. Asphalt curbs.

B. Related Requirements:

1. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the local standards where the project is located for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Asphalt and Aggregate thickness shall be as indicated in the drawings.

2.2 AGGREGATES

A. Aggregate base shall conform to Caltrans Class 2 (maximum ¾”), compacted to a minimum of 95% of maximum dry density (ASTM D1557).

B. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

D. Mineral Filler: ASTM D 242/D 242M, rock or slag dust, hydraulic cement, or other inert material.

2.3 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320.

B. Asphaltic concrete shall be Caltrans, Type B, ¾ inch maximum medium grading.

C. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: Materials for aggregate base shall be as specified in the Geotechnical Report. Aggregate base shall be provided where shown and to the thickness shown. Imported aggregate bases shall be delivered to the job site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. The base material shall be spread and compacted in layers of equal thickness and the maximum compacted thickness of any one layer shall not exceed 6-inches. The relative compaction of each layer of aggregate base shall not be less than ninety-five percent (95%) of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, and smooth to grade.

PART 3 - EXECUTION

3.1 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 3 inches.
2. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.

3.2 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. Any soft pockets shall be repaired.

C. Place pavements on 12 inches of moisture conditioned (at least 2% over optimum) subgrade (native soil) compacted to a minimum of 95% of the maximum dry density determined by ASTM D1557, or the governing agency requirements.

D. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at a minimum temperature of 250 deg F.
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F, or during unsuitable weather as determined by the Engineer.

C. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

D. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

   1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

   1. Compact to a minimum of 95% of the 50 blow Marshall Density (ASTM D1559).

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F.

   1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated in Drawings within the following tolerances:

   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

SECTION 32 31 11 – GATE OPERATORS

PART 1 GENERAL

1.1 SUBMITTALS

A. Action Submittals:
1. Shop Drawings: Illustrate products, installation, and relationship to adjacent construction.
2. Product Data: Manufacturer's descriptive data and product attributes.

B. Closeout Submittals:
1. Operation and Maintenance Data.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Firm specializing in work of this Section, with minimum 5 years of experience.

1.3 WARRANTY

A. Manufacturer's 5-year warranty against material and manufacturing defects.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Contract Documents are based on products by LiftMaster.

B. Substitutions: Specified manufacturer and model, or approved equal.

2.2 MANUFACTURED UNITS

A. Slide Gate Operators:
1. Model: SL3000UL.
2. Operation: Gear driven chain
3. Meet UL 325, UL 991, ASTM F2200, and CAS C22.2 No. 247.
4. Motor: 115 VAC, continuous duty type, sized to gate conditions.
5. Traveling speed: 12 inches per second.
6. Monitoring and controls:
   a. Internet connectivity: MyQ technology with 50 channel FHSS.
   b. Radio receiver: Security+ 2.0 technology.
   c. Monitored retro-reflective photo eyes.
   d. Monitored small profile wired safety edge.
7. Accessories:
   a. Monitored safety devices:
   b. Wired monitored safety edges:
   c. Plug-in loop detector.
   d. Wireless commercial keypad.
   e. Remote control: One-button encrypted DIP remote control.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 CLOSEOUT ACTIVITIES

A. Test and adjust operators for proper operation.

B. Demonstration: Demonstrate operation and programming of operators to Owner.

END OF SECTION

SECTION 330130 - MANHOLE REHABILITATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes work, materials, and equipment required for rehabilitating deteriorated masonry, concrete or metal structures using either: 1. Elastomeric polyurethane coating system, or2. High build 100% solids epoxy coating system, and the use of said system for the protection of the rehabilitated structures.

B. This section covers procedures for surface preparation, cleaning, infiltration/exfiltration control, build-back / repair, application, testing, and inspections.

C. All aspects of the installation for the applicable products selected for use and specified herein shall be in accordance with manufacturer's recommendations and per the specifications.

D. Note that the imagery in the drawings does not necessarily represent existing conditions.

E. Contractor shall confirm all manhole diameters and penetration sizes prior to construction and notify the Engineer or Owner of any discrepancies between field measurements and the Drawings.

F. Prior to bidding on the work, the Contractor is advised to inspect manholes to determine the best method of rehabilitation to stop all inflow and infiltration (I&I) within the identified manhole.

1.02 REFERENCES

A. Standards (where applicable):

a) ASTM D16-93 - Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products
b) ASTM D638 - Tensile Properties of Plastics
c) ASTM G210 - Severe Wastewater Analysis Test (SWAT)
d) ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics
e) ASTM D695 - Compressive Properties of Rigid Plastics
f) ASTM D2584 - Volatile Matter Content
g) ASTM D543 - Resistance of Plastics to Chemical Reagents
h) ASTM C267 - Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes
i) ASTM C109 - Compressive Strength Hydraulic Cement Mortars
j) ASTM D695 - Compressive Properties of Rigid Plastics
k) ASTM D714 - Standard Test Method for Evaluating Degree of Blistering of Paints
l) ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating
m) ASTM D4262 - Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
n) ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester
o) ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars
p) NACE SP0188-2006 Discontinuity (Holiday) Testing on New Protective Coatings on Conductive Substrates
q) ASTM D7234 - Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
r) ASTM G20-88 - Standard Test Method for Chemical Resistance of Pipeline Coatings

s) OSHA 29CFR Occupational Safety and Health Administration (OSHA) 1926/1910 Safety and Health Standards
t) SSPC Steel Structures Painting Council Specifications, Vol. 2
u) SSPC SP-13/NACE No. 6 – Surface Preparation of Concrete
v) SSPWC - Standard Specifications for Public Works Construction "Greenbook", 2009.
w) SSPWC 210-2.3.3 & 211-2 - Chemical Resistance Test (Pickle Jar Test)
x) NASSCO – National Association of Sewer Service Companies, Marriottsville, MD

1.03 DEFINITIONS

A. Coating Systems: All components together as a unit used to repair the structure and protect against further corrosion. These components include, as applicable, grout and defect filler and reprofiling materials for structure walls, ceilings, and floors; material used to repair structure invert and bench areas; infiltration control; and primer and finish coats.
B. Dry Film Thickness (DFT): The thickness of one fully cured continuous application of coating.
C. Applicator: The person assigned by the Contractor to apply the specified coating system.
D. Structure: For coating purposes, a structure is defined as all concrete surfaces including the invert, bench, barrel sections, cone, grade rings, walls, ceiling, floor, metal frame, and all other exposed concrete within the structure.

1.04 SUBMITTALS

A. Detailed and complete testing data pertaining to all the products that will be used within the structure lining system and installations including:
   a) Technical data sheet (TDS) on each product used during the project.
   b) Safety Data Sheet (SDS) for each product used during the project.
B. Material testing data verifying the properties for various listed products where called for in this specification. Include project specific data for repair materials to be top coated with the coating products including application, cure time and surface preparation.
C. For all coating system components, the Contractor shall provide the manufacturer's application instructions, which shall include the following information:
   a) Surface preparation recommendations (allowable damp conditions)
   b) Primer type, where required.
   c) Maximum dry and wet mil thickness.
   d) Minimum and maximum curing time between coats, including atmospheric conditions for each.
   e) Curing time before submergence in liquid.
   f) Thinner to be used with coating material.
   g) Ventilation requirements
   h) Minimum atmospheric conditions during which the coating shall be applied.
   i) Allowable application methods.
   j) Maximum allowable moisture content.
   k) Maximum storage life.
D. Copies of contractor's certification of good standing letter from the manufacturer of the submitted coating and/or underlayment materials.
E. Contractor Qualifications as described in SECTION 1.04 [*Quality Assurance and*

Contractor qualifications]

F. A certificate of "Compliance with Specifications" shall be furnished for the structure rehabilitation materials and installation.

G. Coating System Application Plan – A coating system application plan shall be prepared that includes a description of the following:

a) Quality Assurance procedures:

(1) Training program to qualify personnel in the correct storage and handling of coating materials, and the necessary safety requirements.

(2) List of application and testing equipment to be used, including inspections confirming satisfactory condition of equipment.

(3) Detailed procedures and methods for surface preparation including repair and reprofiling if required, application of primer and final coating, and testing.

(4) Manufacturer's specification containing instructions and quality control procedures.

b) Criteria for acceptance of the preparation of concrete and manhole surfaces.

c) Plan for sewage diversion.

d) Method and material for sealing active leaks to include various levels of infiltration.

e) Detailed plan of surface preparation, including repair and reprofiling.

f) Details of application of primer and finish coats, including required curing times.

g) Detailed environmental provisions such as shading from the sun, dealing with wet weather, or heating during cold weather.

h) Detailed scheduling provisions for environmental considerations such as working at night.

i) Testing procedures for pin holes, coating thickness, and adhesion.

j) Wet film thickness testing.

H. List of materials proposed to be used under this section and manufacturer's data for each material.

I. Written warranty per Part 3.08 from both the coating manufacturer and the Applicator.

1.05 QUALITY ASSURANCE & CONTRACTOR QUALIFICATIONS:

A. Qualifications of coating system Installers / Applicators:

A. Coating material shall be produced in an ISO 9001 certified facility.

B. Furnish materials of quality required by ASTM standards or other approved standards and specifications.

C. Applicators shall have the material Manufacturer's Certification that they have been trained and approved in the handling, mixing and application of specified products for no less than three (3) years.

D. Applicator maintains a permanent place of business in the State of California, and if not located in California, can demonstrate through three (3) references from projects of similar size and scope within the last five (5) years in the State of California, that they were responsive to communications, including defective items and warranty work.

E. Applicator shall provide proof of work experience to Owner indicating contact information within the last five (5) years, to include a minimum of 100 manholes installed in the State of California.

F. Three (3) references of projects similar in size from the past five (5) years of the Applicator indicating successful application of the specified coating/lining system in projects located within the State of California.

G. The same coating system applied by a different applicator shall not be considered proof of experience. The same applicator applying a different coating system shall not be considered proof of experience.

H. Applicators Lead Foreman for the rehabilitation process used shall have had at least three (3) years' experience in similar work and with similar products.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Materials are to be kept in conditions specified by the manufacturer including locations that are dry, protected from weather, and stored under cover.
   a) Protective coating/lining products and all repair materials shall be handled in accordance with their respective material safety data sheets (MSDS).
   b) Materials used shall be transported, stored, mixed, and applied in accordance with written manufacturer recommendations for the specified products.
   c) Protective coating/lining materials are to be stored between 50 deg F and 90 deg F. Do not store near flame, heat or strong oxidants.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Coating systems shall be compatible with the concrete surface preparation methods specified herein.

B. The materials to be utilized in the rehabilitation of structures shall be designed and manufactured to withstand the severe effects of hydrogen sulfide in a wastewater environment. Manufacturer of structural underlayment and corrosion protection products shall have at minimum ten years of manufacturing experience in the production of the lining products found within this specification and shall have satisfactory installation record.

C. The coating shall yield a hard, durable, chemical resistant finished surface and shall be specifically designed to be applied to protect concrete in wastewater applications. The finished coating shall provide a watertight seal and shall adhere to polyvinyl chloride and other components of the pipeline systems.

D. All products and materials shall be manufactured by the same manufacturer for the selected coating system, to ensure material compatibility and quality control.

   a) Approved Manufacturers (either):
      (1) Quadex LLC. (Vortex Companies)
      (2) Sauereisen,
      (3) VersaFlex Companies (Raven),
      (4) Or approved equal.

E. Coating DFT shall be 125 mils minimum. Provide greater thickness where recommended by the manufacturer. The specified thickness shall not include the primer thickness unless otherwise noted.

F. Primer shall be as recommended by the manufacturer.

G. Corrosion Inhibitor for Reinforcing Steel: Reinforcing steel, exposed by corrosion or during surface preparation, shall be treated with a water-based epoxy resin, anti-corrosion coating, and bonding agent, such as Armatec 110 EpoCem, manufactured by the Sika Corporation, or approved equal.

H. Risers, Grade Rings, and Frame: Manhole risers, grade rings, and manhole frame shall be sealed with the same corrosion-resistant material used throughout the manhole.

I. Bonding Compounds: All surfaces where new concrete will be bonded with existing concrete shall be coated with a bonding compound as recommended by the manufacturer of the concrete repair material.

J. Defect filler and repair materials shall be as specified herein or as recommended by the manufacturer and shall be covered under the same warranty as the rest of the coating system.

2.02 INFILTRATION / INFLOW CONTROL

A. This section is intended to cover the methods, procedures, and materials as required to eliminate heavy to mild and moderate water infiltration and/or exfiltration using an injectable, two-part polyurethane resin system, a hydraulic cement material, or an approved equal material.

a) Injection Grouting material shall follow approved Manufacturer's installation instructions.

b) All fast-setting cementitious materials furnished shall be formulated to be applied in dry powder form, with no prior mixing of water, directly to active leaks under hydrostatic pressure, and shall be approved prior to installation.

2.03 PATCHING, INVERT SHAPING AND BENCH UNDERLAYMENT MATERIALS

A. Shall be high strength, quick setting, corrosion resistant cementitious material mixed and applied according to manufacturer's recommendations. The high strength, quick setting mortar shall have the following minimum characteristics:

Characteristic	Minimum Requirement	Specification
Compressive Strength	4,000 psi, 24 hours	per ASTM C109

A. Approved Manufacturers/Products: Quadex® Hyperform® or approved equal.

2.04 WALL STRUCTURE UNDERLAYMENT MATERIALS

A. Underlayment of the structure walls shall be with the use of premium Portland cement based, single-component, high-strength, fiber-reinforced, shrinkage-compensated cement mortar enhanced with a monocrystalline quartz aggregate and shall have the following minimum characteristics at 28-days:

Characteristic	Minimum Requirement	Specification
Compressive strength	28 Day >9000 psi	ASTM C39 or C109
Flexural strength	28 Day ≥1000 psi	ASTM C78 or C293
Bond Strength	28 Day ≥1500 psi	ASTM C882

B. Approved Manufacturers/Products:

a) Quadex® QM1s-Restore® or approved equal.

PART 3 - EXECUTION

3.01 FLOW CONTROL OR BYPASS

A. At minimum, flow control shall be sufficient to allow the application of the materials specified herein to take place.
B. Full bypass may be required if flow control alone does not provide sufficient conditions to successfully complete the application process.

3.02 SEALING ACTIVE LEAKS

A. The Certified Applicator shall apply an approved quick-setting mortar or chemical grout in accordance with Manufacturer's recommendations and in accordance with Section 2.02 of this specification.
B. After defects in the structure are identified, repair all leaks with a chemical or hydraulic sealant designed for use in field sealing of ground water. Severe cracks shall be "repaired with a urethane-based chemical" sealant, or equal. Product to be utilized shall be as approved by owner/engineer prior to installation. Repairs to exposed rebar, defective pipe penetrations or inverts, etc. shall be repaired utilizing non-shrink grout or approved alternative method.

3.03 BUILD UP STRUCTURE WALLS/FLOORS TO UNIFORM SURFACE

A. Raise existing concrete surfaces to provide smooth, uniform surface. Additional underlayment may be required in areas with more severe degradation and shall have a brushed finish without irregularity or pockets.

3.04 SURFACE PREPARATION OF STRUCTURES FOR APPLICATION OF COATING SYSTEMS

A. Contractor and Manufacturer's Representative shall inspect all surfaces specified to receive a coating system prior to surface preparation. The Contractor shall notify the Owner or Owner's Representative of any noticeable disparity in the surfaces, which may interfere with the proper preparation or application of the coating system.
B. Existing concrete and masonry substrates must be prepared in a manner that provides a uniform, sound, clean, neutralized surface with sufficient profile suitable for the specified underlayment material. The substrate must be free of all contaminants, such as oil, grease, hydrocarbons, rust, scale or deposits and have a surface profile equivalent to a CSP-3 to CSP-5 in accordance with ICRI Technical Guideline No. 03732. This can generally be achieved by abrasive blasting, shot blasting, high pressure water cleaning, water jetting, acid etch, grinding, hot water/steam/detergent cleaning, or a combination of methods. Cleaned, or prepared surface shall be compatible for installation of the liner system.
C. Surface preparation method shall produce a cleaned, abraded and sound surface with no evidence of laitance, loose concrete, mortar, contaminants or debris, and shall display a surface profile suitable for application of liner system.
D. Conduct surface preparation program to include monitoring of atmosphere for hydrogen sulfide, methane, low oxygen or other gases, approved flow control equipment, and surface preparation equipment.

3.05 REINFORCING STEEL TREATMENT

A. Procedures: Where corrosion or surface preparation activities have exposed reinforcing steel, the following procedure shall be used:
   a) If half the diameter of the reinforcing steel, or more, is exposed, chip out behind the reinforcing steel a minimum of 1/2-inch for placement of grout or polymer concrete.
   b) Determine section area loss of reinforcing steel.
   c) Where reinforcing steel cross-section area loss exceeds 15 percent of the original reinforcing steel, perform structural repair as directed by the Engineer.
   d) Abrasive-blast all exposed reinforcing steel surfaces to remove all contaminants and corrosion products.
   e) Apply a 20-mil (wet) coat of corrosion inhibitor to all surfaces of the clean, exposed reinforcing steel with a stiff brush or spray equipment. Cure to tack-free 2 to 3 hours.
   f) Apply a second 20-mil (wet) coat of corrosion inhibitor and allow for a 2- to 3-hour cure prior to placement of polymer mortar or grout.

3.06 COATING SYSTEM APPLICATION

A. Prior to application of the selected topcoat to each structure, the Contractor shall have properly prepared the structure per specifications and per manufacturer’s recommendation.
B. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment. Structure surface shall be free of surface moisture prior to application.
C. Spray equipment shall be specifically designed to accurately ratio and apply the liner system.
D. Application of multi-layer/component liner system shall be in strict accordance with manufacturer's recommendations.

3.07 CURING

A. Shall follow the material curing guidelines as specified by the manufacturer.

3.08 CLEANUP

A. Upon completion of coating, the Contractor shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean all surfaces and repair any overspray, splashes, splatters or other coating-related damage. Surfaces damaged resulting from this cleanup shall also be cleaned, repaired, and refinished to the original or required condition.

3.09 CONSTRUCTION TESTING

A. Visual Inspection:
   A. A final visual inspection shall be made by the Owner and manufacturer’s representative. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Applicator.

B. Epoxy Corrosion Protection Coating:

A. Holiday Detection:

a) Contractor shall, after the protective lining has set hard to the touch, inspect with high-voltage holiday detection equipment. The spark tester shall be initially set at 100 volts per 1 mil of film thickness applied but may be adjusted as necessary to detect in induced holiday. All detected holidays shall be repaired following the protective coating manufacturer's recommendation.

B. Adhesion Testing (Pull-Off Test):

a) Adhesion Testing is a destructive test method and should be used in moderation as an evaluation tool.

b) Testing shall be conducted in accordance with:

(1) ASTM D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers or ASTM D7234 Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.

(2) 20 mm loading fixtures (dolly/stud) shall be used on curved infrastructure such as circular manholes. Larger dollies may be used on flat infrastructure as allowed by ASTM.

(3) For each test structure, recommended to include no more than 10% of the total count of lined structures unless further concerns are noted, a minimum of three dollies shall be affixed to the coated surface.

(4) The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths in excess of at least twice the anticipated failure point (generally at least 1000 psi). Tests failing within the substrate, even if failing to meet specified adhesion requirements, shall be considered passing as the Contractor has no control over the performance of the existing infrastructure (ASTM D7234 Appendixes X1).

3.10 WARRANTY:

A. The Contractor shall provide a written warranty from the coating manufacturer for the entire coating system, including all repair material, defect fillers, primers, intermediate, and finish coats. The minimum duration of the warranty shall be 5 years. The product and the installation may both be covered by the manufacturer's warranty, or separate warranties may be issued by the manufacturer and the installer.

B. This warranty shall state that the coating will not fail for a minimum period of 5 years. Coating failure is defined as blistering, cracking, embrittlement, or softening, or failure to adhere to the substrate.

C. The warranty shall also apply to any repair materials, primers, or other products used in the application. If any repair or replacement is necessary within the warranty period, a new 5-year warranty period shall start at the date that the structure is placed back into service.

D. The Contractor shall have 45 days to respond and take corrective measures should the Owner discover any coating failure during the warranty period. The 5-year warranty period for all manholes shall start on the final completion date of the project. All manhole warranties shall start on the same date regardless of when the manhole was placed back into service.

END OF SECTION 330130

SECTION 330505 – PIPELINE TESTING

PART 1 - GENERAL

1.1. SUMMARY

A. The Contractor shall perform flushing and testing of all pipelines and appurtenant piping complete, including conveyance of test water from Owner-designated source to point of use and all disposal thereof, all in accordance with the requirements of the Contract Documents.

B. Section includes provisions for following piping testing:

a. Testing of alignment, grade, and deflection;
b. Gravity flow piping testing;
c. Hydrostatic High Head pressure testing;
d. Hydrostatic Low Head pressure testing;
e. Low pressure air testing;
f. High pressure air testing.

1.2. RELATED SECTIONS

A. General Pipes and Fittings. Section 220050

B. Ductile Iron Pipe. Section 400519

C. Plastic Pipe. Section 400531

D. High Density Polyethylene Pipe and Fittings. Section 400533

E. Stainless Steel Piping and Tubing. Section 400523

F. Steel Piping and Fabricated Steel piping. Section 400524

G. Water Piping. Section 221116

H. Sanitary Waste and Vent Piping. Section 221316

I. Hydraulic Structure Testing. Section 331400

1.3. SUBMITTALS

A. Schedule and Notification of tests:

a. Submit a list of scheduled piping tests by noon of working day preceding the date of scheduled tests.
b. Notification of readiness to test: Before testing notify the Engineer or Construction Manager in writing of readiness to test piping.

c. Have personnel, materials, and equipment required for testing in place before submitting notification of readiness.

B. Provide a test report for each piping system tested. Include the following:

a. Date of Test;
b. Description and identification of piping system tested;
c. Results of alignment, grade, and deflection testing;
d. Type of test performed;
e. Test fluid;
f. Test pressure;
g. Type and location of leaks detected;
h. Corrective action taken to repair leaks;
i. Results of re-testing.

C. Submit test report in accordance with Specification Section 13300.

1.4. SEQUENCE

A. Test Piping Systems as follows:

a. Clean piping before pressure or leak tests.
b. Test exposed, non-insulated piping systems upon completion of system (including supports, hangers, anchors, etc.)
c. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
d. Test concealed interior piping systems prior to concealment and, if system is insulated prior to application of insulation.
e. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
f. Test buried piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 - PRODUCTS

2.1. MATERIALS REQUIREMENTS

A. All test equipment, temporary valves, bulkheads or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review.

PART 3 - EXECUTION

3.1. GENERAL

A. Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use.

B. All pipelines shall be tested. All testing operations shall be performed in the presence of the Construction Manager.

C. Provide air supply.

D. Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts.

E. Add test fluid slowly.

F. Include regulator set to avoid over-pressurizing and damaging piping.

G. Perform pressure testing in accordance with local, state, and federal requirements.

H. Correct leaks or defects at no additional cost to Owner and as approved by the Engineer.

I. Disposal or release of test water from pipelines after testing, shall be acceptable to the Engineer.

3.2. TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and grade:

a. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
b. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection test:

a. Pull a mandrel through the clean piping section under test.
b. Perform the test no sooner than 30 days after installation and not later than 60 days after installation or permanent surfacing.
c. Use a full circle, solid cylinder, or a rigid non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder mandrel approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

3.3. TESTING OF GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with “G” in piping schedule, as follows:

a. Unless specified otherwise, subject gravity flow piping to the following tests:

i. Alignment and grade.
ii. For plastic piping test for deflection.
iii. Visible leaks and pressure with maximum leakage allowance.

b. Inspect piping for visible leaks before backfilling.
c. Provide temporary restraints when needed to prevent movement of piping.
d. Pressure test piping with maximum leakage allowance after backfilling.
e. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under the head indicated in the piping schedule for the water at least 24 hours:

    i. Examine piping for visible leaks. Correct any visible leaks. Consider examination complete when no visible leaks are observed.
    ii. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
    iii. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of 4 hours while accurately measuring the volume of water added to maintain the test pressure:

        1. Consider the test completed when leakage is equal or less than the following maximum leakage allowance:

            a) For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test.
            b) For HDPE Strom Drain Piping use manufacturer recommended leakage rates.
            c) Test sanitary waste and vent piping in accordance with section 221316 requirements.
            d) For other piping: 80 gallons per day per inch diameter per mile of piping under test.

B. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

C. Test waste, drain and vent systems in accordance with local plumbing code and these specifications. Repair failed sections by disassembly and reinstallation.

3.4. HYDROSTATIC HIGH HEAD TESTING OF PIPELINES

A. Test piping indicated “HH” in the Piping Schedule with the high head pressure test method.

B. General:

a. The test pressure for yard piping shall be as shown or specified on the Piping Schedule measured at the lowest point of the pipeline section being tested. Where not indicated in the Piping Schedule, test piping systems at 150% of the operating pressure indicated, but not less than 25 psi. Observe each test section for leakage at the end of the test period. Test fails if leakage is observed or if there is any pressure drop in the system. All leaks shall be repaired in a manner acceptable to the Engineer.
b. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Care shall be taken to see that all air vents are open during filling. Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is

installed, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

C. Testing Procedures:

a. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled it shall be allowed to stand under a slight pressure for at least 24-hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.
b. Use potable water for all potable water lines testing.
c. Test piping for minimum 2 hours for visible leaks and minimum 2 hours for the pressure test with maximum leakage allowance.
d. Raise pressure to the specified test pressure and inspect piping visually for leaks:

i. Correct any visible leaks,

ii. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:

a. Leakage allowance is zero for all exposed (insulated or non-insulated) piping and all piping systems using flanged, National Pipe Thread threaded and welded joints.
b. Pressure test piping after completion of visible leaks test.
c. Buried piping with mechanical joints or push-on joints, piping systems shall have maximum allowable leakage of

$$L = (NxDxP^{(1/2)})/7{,}400$$

Where:
L = Leakage, gallons per hour
N = Number of joints under test
D = Nominal diameter of piping, inches
P = Average pressure during test, pounds per square inch
x = multiplication symbol.

E. Pressure test HDPE pipe in accordance with the requirements of section 221050 “High Density Polyethylene Pipe and Fittings”.

F. Pressure test potable water piping in accordance with the requirements of section 221116 “Water Piping”.

G. Pressure test PEX piping systems in accordance with the requirements of section 238316.

H. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

I. Drain and dispose of test water from piping systems as directed by the Construction Manager or Engineer after testing and repair work has been completed.

J. Test all pressure piping in accordance with ANSI B31.

3.5. HYDROSTATIC LOW HEAD TESTING OF PIPELINES

A. Test piping indicated “LH” in the Piping Schedule with the low head pressure test method.

B. General:

a. Test pressures shall be as noted in the pipe schedule.
b. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
c. Test connections, blowoffs, vents closure pieces, and joints into structures including existing bell rings and other appurtances with the piping.
d. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible Leaks Test:

a. Subject piping under test to the specified pressure measured at the lowest end.
b. Fill piping under test slowly with water while venting air:
    i. Use potable water for all potable waterlines.
c. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
d. Raise pressure to the specified test pressure and inspect piping visually for leaks. Correct any visible leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance.

a. Pressure test piping after completion of visible leaks test.
b. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
    i. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test and no damage to piping and appurtances has occurred.
    ii. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtances has occurred.

3.6. LOW PRESSURE AIR TESTING

A. Perform low pressure air testing for gravity sewer and drainage piping systems where indicated “AL” in the Piping Schedule.

B. Test pipes between adjacent manholes. Test time for air pressure to drop 1.0 psi.

a. For pipes 4 in. through 36 in. diameter to comply with Table 1.

b. Pipe over 36 inch diameter shall not be tested by the low pressure air method.

C. Preparation:

a. Isolate pipe section to be tested by plugging each end with air tight plugs. Plug end of branches, laterals and wyes which are not to be included in the test section.
b. Brace plugs to prevent slippage and blowout due to internal pressure.
c. One plug shall have inlet tap or other provision for connecting air supply.
d. Air control equipment shall consist of valves and pressure gauges to control rate at which air flows into test section and gauges to monitor air pressure inside pipe.

D. Testing:

a. If pipe to be tested is submerged in water, determine height of water above spring line of pipe at each end of test section and compute average. For each foot of water above pipe's spring line, increase test pressure by 0.43 psi.
b. Add air slowly until pressure inside pipe is raised to 5.0 psi. greater than average back pressure of water that may be over pipe.
c. After pressure of 5.0 psi is obtained, control supply of air so the internal pressure is maintained between 4.5 and 5.0 psi (above average water back pressure) for minimum of 2 minutes to allow temperature of air to come into equilibrium with temperature of pipe.
d. In no case shall the test pressure exceed 9.0 psi or the maximum pressure allowed by the pipe manufacturer.
e. Determine the rate of air lost by time pressure drop method.
    i. After temperature stabilized for a 2 minute period, disconnect air supply. Allow pressure to decrease to 4.6 psi. At this pressure, start stopwatch to determine time required for pressure to drop 1.0 psi. Time required for loss of 1.0 psi is then compared to Table 1.
    ii. If time is equal to or greater than time indicate din table, test shall be acceptable.
    iii. If time is less than time indicated in table, make appropriate repairs and retest.

Table 1. Low Pressure Air Test Times for 1.0 PSIg Pressure Drop.

Pipe Diameter (in)	Minimum Time for 1.0 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length (L) in Excess of Minimum (sec.)
4	03:47	597	.380L
6	05:40	398	.854L
8	07:33	298	1.520L
10	09:27	239	2.374L
12	11:20	199	3.418L
15	14:10	159	5.342L
18	17:00	133	7.692L
21	19:50	114	10.470L
24	22:40	99	13.674L
27	25:30	88	17.306L
30	28:20	80	21.366L
33	31:10	72	25.852L
36	34:00	66	30.768L

E. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

3.7. HIGH PRESSURE AIR TESTING

A. Perform high pressure air testing for gravity sewer and drainage piping systems where indicated "AH" in the Piping Schedule.

B. Perform preliminary test at not greater than 25 psi. Examine for leakage at joints with soap solution and visual detection of soap bubbles. Correct visible leaks.

C. Perform final test at the pressure specified. Pressure in the system shall be gradually increased until the test pressure is reached. Test pressure shall be maintained for a minimum of 10 minutes and additional time conduct soap bubble test examination of each joint for leakage.

D. Piping system shall show no evidence of leakage. If leakage is evident, make appropriate repairs and retest.

END OF SECTION 330505

SECTION 331400 – HYDRAULIC STRUCTURES TESTING

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all cleaning, flushing, testing and appurtenant work, including conveyance of test water from Owner-designated source to point of use, and including all disposal thereof, complete and acceptable, for hydraulic structures and appurtenant piping all in accordance with the requirements of the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Pipeline Testing. Section 330505

B. Cast-In-Place Concrete. Section 033000

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Temporary valves, bulkheads or other water control equipment and materials shall be as determined by the Contractor subject to the Engineer's review.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to testing, all hydraulic structures shall be thoroughly cleaned and all surfaces hosed down with a high pressure hose and nozzle. All water, dirt and foreign material accumulated in this cleaning operation shall be removed from the structure.

B. The Contractor shall conduct leakage testing of concrete structures subject to hydrostatic pressure and all appurtenant piping. All testing operations shall be done in the presence of the Engineer.

C. The Contractor shall notify the Engineer at least 48-hours in advance of any planned testing and shall review with the Engineer the testing procedures.

D. Water from the Owner’s reclaimed water system will be provided for testing. However, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use.

E. If industrial paint finishes or other protective coatings are to be applied to the interior surfaces of the hydraulic structure, such coatings shall be applied after all testing operations have been completed.

F. Disposal of test water from structures, after testing has been completed, shall be acceptable to the Engineer.

3.2 TESTING OF HYDRAULIC STRUCTURES

A. General: Testing shall be performed prior to backfilling, except where otherwise acceptable to the Engineer (See drawings for additional requirements). Testing shall not be performed sooner than 14-days after all portions of structure walls and associated roof systems have been completed. The test shall consist of filling the structure with water to the maximum operating water surface. The rate of filling shall not exceed 48-inches of depth per day.

B. Evaporation Calculations: To accurately measure the amount of evaporation, the following procedure shall be observed:

1. A standard 5 gallon bucket shall be filled just below the top, and the elevation noted. The bucket shall then be placed in the water of the structure being tested once filling of the structure is complete.
2. Upon completion of the hydraulic testing of the structure, the amount of water evaporated from the bucket shall be taken as the evaporation amount in the structure.

C. Leakage Test and Repairs: After the structure has been filled, the leakage test shall be performed as follows: An initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the two water level readings, does not exceed 0.2 percent of the total volume of water in the structure, after allowance is made for evaporation loss. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before commencing a new 7-day test period. If the structure continues to fail the leakage test, the Contractor shall empty the structure and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage. Any cracks shall be "vee'd" and sealed with polyurethane sealant in accordance with Section 033000 entitled, "Cast-In-Place Concrete". Any evidence of leakage shall be repaired. Following these operations, the Contractor shall again test the hydraulic structure. The structure will not be accepted as completed until it has passed the leakage test.

3.3 TESTING OF APPURTENANT PIPING

A. Piping appurtenant to hydraulic structures shall be tested as specified in Section 330505 entitled, "Pipeline Testing".

END OF SECTION 331400

SECTION 338000 - PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide precast concrete manholes, catch basins, drop inlets, potable water vaults; meter vaults, and other pre-cast concrete structures complete and in place, in accordance with the Contract Documents.

1.2 RELATED SECTIONS

A. Section 033000 – Cast-in-place Concrete

B. Section 312000 – Earth Moving

1.3 SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

ASTM A 48	Gray Iron Castings.
ASTM C 150	Portland Cement.
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 877	Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.4 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 013300 - Contractor Submittals.

B. Shop Drawings:

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
2. Structural design calculations for vaults and boxes shall be stamped and signed by a structural engineer registered in the State of California.

C. Manufacturer’s Certification for Manholes and Vaults: Written certification that the structure complies with the requirements of this Section.

D. Manufacturer’s Test Results: Pull out force for manhole steps.

1.5 QUALITY ASSURANCE

A. Inspection: After installation, the Contractor shall demonstrate that manholes and vaults have been properly installed, level, with water-tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

B. Any precast concrete which arrives on site with voids, cracked, or damaged, or is cracked or damaged during installation shall be cause for rejection. Contractor shall remove precast section(s) from the project site and replace with new undamaged sections at no additional cost to OWNER.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle precast units in positions consistent with their shape and design. Lift and support only from the support points indicated on the shop drawings.

B. Embedded Lifting or Handling Devices: Capable of supporting units in positions anticipated during manufacturing, storage, transportation and installation.

C. Block and brace units during storage. Provide lateral bracing which is sufficient to prevent bowing and/or warping and will not inhibit curing of the exposed surfaces.

PART 2 - PRODUCTS

2.1 MANHOLES

A. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Cement used in manufacturing the manholes shall be Type II modified Portland cement in accordance with ASTM C 150.

1. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints. Joints shall be minimized and shall be located as close as possible to the top of the structure to help minimize opportunity for groundwater infiltration.

C. Conical sections shall have an eccentric shape and shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

D. Design Criteria: Manhole walls, transitions, conical sections, and base shall be designed per ASTM C 478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.
2. Unit weight of soil of 120 pcf located above all portions of the manhole.
3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.
4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.
5. External pressures and uplift forces due to groundwater elevations 2 feet below finish grade.
6. Dead load of manhole sections fully supported by the base and transition.
7. Additional reinforcing steel in walls to transfer stresses at openings.

8. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.

E. Joints shall have lipped male/female ends which shall provide uniform and continuous interior wall surfaces and shall be watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990.

F. Raw Sewage, Plant Drain, drain manholes, plant effluent and all vaults shall also have each joint wrapped with an external joint sealant meeting ASTM C 877. Concrete for base and channel formation shall be 4000 psi concrete conforming to Section 033000 –Cast-In-Place Concrete.

G. Barrel section to sewer pipe (Raw sewage, plant drain, drain, and plant effluent) connections shall be sealed with flexible resilient connectors complying with ASTM C923 and appropriate for the pipe material being used. Mechanical devices shall be stainless steel.

H. Where required and specified in drawings, manhole steps shall be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches. Furnish test results demonstrating step capability to resist a pull out force of 2200 pounds.

I. Manhole riser sections shall be greater than 12 inches in height.

J. Manhole Manufacturers, or Equal

1. Jensen Precast
2. OLDCASTLE Precast

2.2 FRAMES AND COVERS

A. Castings: Castings for manhole frames, covers, and grates shall be non-rocking with machined flat bearing surfaces, and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter. Covers shall have cleated surfaces with pick holes and shall be ventilated in improved areas and have a solid lid design in landscape or native areas.

B. Manhole covers shall be with embossed with lettering saying "Sewer".

C. Unless noted otherwise all frames and covers shall be designed for H-20 traffic loading. Grates and curb inlets in traffic areas shall be designed for H-20 traffic loading.

D. Castings Manufacturers, or Equal

1. D & L Supply
2. Neenah Foundry Co.

2.3 VAULTS

A. The Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V Portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:

L = 90 h, plus surcharge of 240 psf in areas of vehicular traffic
Where L = loading in psf
h = depth of fill in feet.

D. Unless noted otherwise design loading shall also take into account the lateral and uplift pressure resulting from a groundwater elevation 2 feet below existing grade.

E. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint. All openings through the precast structure shall be reinforced to transfer loads.

1. Joints shall be sealed watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990. In addition, all joints shall be wrapped with an external joint sealant meeting ASTM C 877.

F. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

G. Covers for access openings shall be provided. Frames for covers shall be fabricated from aluminum, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

H. Where penetrations of the pre-cast concrete vaults are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or wall sleeves, as indicated. Storm drain structures may also use thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. With the exception of vaults on pressurized water system, vaults need not be designed to resist thrust from piping passing through the vault.

I. Lifting holes shall be plugged with a precast concrete plug sealed with a non-shrink grout.

J. Vault Manufacturers, or Equal

1. Jensen Precast,
2. OLDCASTLE Precast

2.4 FABRICATION

A. Maintain plant records and quality control program during fabrication of structural precast concrete sections. Make all quality control records available to Engineer upon request.

B. Use molds that are rigid, and constructed of material that will result in uniform finished surfaces.

C. If self-consolidating concrete is not used, thoroughly vibrate concrete to ensure proper consolidation, elimination of cold joints, and to minimize trapped air on at the concrete surface.

D. Fabricate and provide the required lifting devices which are compatible with embedded components.

E. Ensure reinforcing steel, anchors, inserts, plates, angle and other cast-in items are sufficiently embedded, properly secured, and correctly located. Ensure the reinforcing steel is properly supported to prevent movement or shifting during fabrication. Inadequate concrete cover over reinforcing shall be cause for rejection.

F. Cure precast concrete sections under identical conditions to develop specified concrete quality.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to accepting manholes on site, ensure that manhole meet the requirements of these specifications, are constructed of the correct materials, and are not cracked or damaged in any other way.

B. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.

C. Buried pre-cast concrete vaults and manholes shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults and manholes shall be set to grade, plumb and level, and oriented to provide the required dimensions and clearances from pipes and other structures.

D. Prior to backfilling vaults, pipe and conduit penetrations and other, openings shall be sealed with polyurethane sealant or as indicated in the drawings. With the authorization of the Engineer, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

3.2 MANHOLES

A. Connect pipe to manhole with flexible connection (unless noted otherwise), as recommended by connection manufacturer. Provide a pipe joint or additional flexible connection 18 inches from the outside of the manhole. Grout around pipe after installation is complete, unless otherwise indicated. All connections shall be watertight.

B. Place top section, cone section or flat slab on top riser section, with the opening positioned over the steps. Top of cone section or flat slab shall be from 10 to 18 inches below finished grade.

C. Install grade rings as required to adjust top of lid and frame to match finish grade elevation. Maximum height of grade rings shall be 12 inches. Maximum number of grade rings shall be two.

D. In paved areas and as indicated in the plans, concrete collars shall be constructed around manhole covers as indicated. Collars shall be of 4000 psi concrete. Collars shall be constructed after pavement has been placed.

E. Steps shall be cast-in-place or vibrated into green concrete.

F. Steps shall be installed 12-inches on centers vertically, not more than 1/2 inch out of plumb. The top step shall be no more then 12-inches below the manhole cover.

G. After manhole base has been completed, furnish and install temporary pipe plugs to seal all interior pipe opening. Plugs shall remain in place until final review and acceptance of completed pipeline. Plugs shall then be removed and shall be property of Contractor.

H. Manhole interiors shall be coated as indicated in the protective coatings schedule.

3.3 QUALITY CONTROL

A. Manholes shall be tested and accepted per the requirements of Section 331400 – Hydraulic Structures Testing. Precast concrete testing is the responsibility of the Contractor and supplier.

B. Do not install precast concrete units until concrete has attained its design compressive strength.

END OF SECTION 338000

SECTION 400500-PIPING, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, seismic restraints, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.

B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWS D1.1	Structural Welding Code
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D 2000	Classification System for Rubber Products in Automotive Applications

1.3 CONTRACTOR SUBMITTALS

A. Submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in Section 013300 –Contractor Submittals, and as indicated in the individual piping sections. The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports and seismic restraints necessary to accommodate the equipment and valves provided in a complete and functional system.

B. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

C. Submit as part of the shop drawings a statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

B. Tests: Except where otherwise indicated, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. Perform all tests at no additional cost to the Owner.

C. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing Work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. Furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain perfect pipe joints, supports, or special connections, furnish such assistance at no additional cost to the Owner.

1.6 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.7 CLEANUP

A. After completion of the Work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipes, fittings, and appurtenances shall be furnished in accordance with the requirements of the applicable Sections of Divisions 22, 23, 33, 40 and this Section.

B. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of Section 400507 – Hangers and Supports for Process Piping, and as indicated.

C. Lining: All requirements pertaining to thickness, applications, and curing of pipe lining, shall be in accordance with the requirements of the applicable Sections of Division 40 , unless otherwise indicated.

D. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, shall be in accordance with the requirements of the applicable Sections of Division 40, unless otherwise indicated. Pipes above ground or in structures shall be field-painted in accordance with Section 098000 – Protective Coatings.

E. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 330505 - Pipeline Testing, or as indicated on the piping schedule.

F. Grooved Piping Systems: Piping systems with grooved joints and fittings may be provided, if approved by the Engineer, in lieu of screwed, flanged, welded, or mechanical joint systems for steel and ductile iron yard piping above and below ground. All grooved couplings on buried piping must be bonded. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. The Contractor shall make the coupling manufacturer responsible for the selection of the correct style of coupling and gasket for each individual location.

2.2 PIPE FLANGES

A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-pound class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-pound class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI B16.5 300-pound class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.

B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.

C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. Flange Bolts: Contractor shall supply all bolts and nuts in conformance with Section 055000 – Metal Fabrications. Studs and bolts shall extend through the nuts a minimum of 1/4 inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

E. Insulating Flanges: Insulated flanges shall have bolt holes 1/4 inch diameter greater than the bolt diameter.

F. Insulating Flange Sets: Insulating flange sets shall be provided by the Contractor where shown. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2 inches or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be two-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325. Insulating gaskets shall be full-face.

G. Insulating Flange Manufacturers, or Equal
1. JM Red Devil, Type E
2. Maloney Pipeline Products Co., Houston
3. PSI Products, Inc., Burbank, California.

H. Flange Gaskets: Contractor shall provide flange gaskets for all pipe flanges. Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of asbestos-free aramid fiber base, with nitrile binder and nonstick coating, suitable for temperatures to 700 degrees F, a pH of 1 to 11, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

I. Flange Gasket Manufacturers, or Equal
1. John Crane, Style 2160.
2. Garlock, Style 3000.

2.3 THREADED INSULATING CONNECTIONS

A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other nonconductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. Construction: Cast mechanical-type couplings shall be provided where shown. The couplings shall conform to the requirements of ANSI/AWWA C606. Bolts and nuts shall conform to the requirements of Section 055000 – Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. The Contractor shall have the coupling Manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation.

B. Couplings for Steel Pipe, Manufacturers, or Equal
   1. Victaulic Style 44 with Type D Heavy Duty Grooved Adaptor Ends.

C. Ductile Iron Pipe Couplings, Manufacturers, or Equal
   1. Victaulic Style 31 (flexible or rigid grooving as specified in drawings).
   2. Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Couplings for PVC Pipe, Manufacturers, or Equal
   1. Victaulic Style 775.
   2. Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends. Grooved end couplings shall be used on PVC pipe only for Schedule 80 vent piping at the vaults. Grooved end couplings shall not be used for PVC C905 water pipe.

2.5 SLEEVE-TYPE COUPLINGS

A. Construction: Sleeve-type couplings shall be provided where indicated, in accordance with ANSI/AWWA C219 unless otherwise indicated, and shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings. The middle ring shall be not less than 1/4 inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 055000 – Metal Fabrications. Buried sleeve-type couplings shall be epoxy-coated at the factory.

B. Pipe Preparation: The ends of the pipe, where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64 inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer.
   1. The rubber in the gasket shall meet the following specifications:
      a. Color - Jet Black.
      b. Surface - Nonblooming.
      c. Durometer Hardness - 74 " 5.
      d. Tensile Strength - 1,000 psi Minimum.
      e. Elongation - 175 percent Minimum.

2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the requirements of the appropriate reference standard, or as shown.

F. Manufacturers, or Equal
1. Dresser, Style 38.
2. Ford Meter Box Co., Inc., Style FC1 or FC3.
3. Smith-Blair, Style 411.
4. Baker, Series 200

2.6 FLANGED END CONNECTORS

A. Flanged coupling adapters, shall be in accordance with AWWA C219.

B. Dismantling joints for connecting flanged pipe shall be AWWA C219 compliant. Provide studs and nuts to seal gasket separate and independent from tie-bar restraint system.

C. All dismantling joints shall be the restrained type per AWWA M-11. Tie-bar restraint system shall conform to ASTM A193-B7 per AWWA M-11 and be designed to withstand the test pressure shown on the Drawings.

D. All dismantling joints shall use standard flanges in accordance with AWWA C207. The thickness of the dismantling joint flanges shall be equal to or greater than the class of flange that is connected to as required by the test pressure as shown on the drawings. Buried flanges shall be wrapped with petroleum was tape per AWWA C217.

E. Manufacturers, or Equal
1. Smith-Blair, Style 972 or 975
2. Baker, Series DJ

2.7 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where shown. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise shown. The connectors shall be 9 inches long, face-to-face flanges, unless otherwise shown. The final material selection shall be approved by the manufacturer. Submit manufacturer's shop drawings and calculations.

2.8 EXPANSION JOINTS

A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement, without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. Submit detailed calculations and manufacturer's shop drawings, guaranteeing satisfactory performance of all proposed expansion joints, piping layouts showing all anchors and guides, and information on materials, temperature and pressure ratings.

2.9 PIPE THREADS

A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1.

2.10 AIR AND GAS TRAPS

A. Air and gas pipes shall be sloping to low points, provided with drip legs, shutoff valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-pound iron body float type with stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers, or Equal
   1. Armstrong Machine Works.
   2. Spirax Sarco, Inc.

PART 3 - EXECUTION

3.1 GENERAL

A. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Divisions 22 and 40. The lining manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints at screwed flanges shall be epoxy-coated, to assure continuous protection.

B. Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.

C. Flanges shall be installed at least 6-inches from a wall. Fittings shall be installed with sufficient clearance for maintenance and removal and reinstallation.

D. All buried non-metallic piping, 4” and greater, shall have both a marking tape placed 12” above the pipe, and a tracer wire placed on top of the pipe. Tracer wire shall be 12 gauge solid copper wire with a plastic coat to prevent corrosion. The tracer shall be secured to the pipe 10 feet and at all bends. Tracer wire shall not be wrapped around a pipe. Tracer wire installation requires access points at least every 300 feet. At access points the tracer wire is brought up to grade with valve boxes, cleanouts, manholes, vaults, or other covered access devices. Splices in tracer wire should be made with split bolt or compression-type connectors. Wire nuts shall not be used. Testing of tracer wire continuity after installation shall be performed.

END OF SECTION 400500

SECTION 400507 – HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide pipe supports, seismic restraints, hangers, guides, and anchors, complete, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 013300 – Contractor Submittals.

B. Shop Drawings: Shop drawings shall include the following information:
1. Drawings of pipe supports, restraints, hangers, anchors, and guides
2. Calculations for special supports and anchors.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Code Compliance: Piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. Supports and parts thereof shall conform to the requirements of ASME B31.1 – Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members: Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the Engineer.

C. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. Hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. Hanger rods shall be subject to tensile loading only.

D. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers: Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. Spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least four times the maximum travel due to thermal expansion.

F. Thermal Expansion: Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. Components shall be structurally suitable to withstand loads imposed.

G. Heat Transmission: Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports: Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.

J. Materials of Construction:
   1. General: Pipe support assemblies, including framing, shall be steel construction, galvanized after fabrication, with Type 316 stainless steel hardware, and anchors, unless otherwise indicated.
   2. Submerged Supports: Submerged piping, as well as piping, conduits, and equipment in hydraulic structures within 24 inches of the water level, shall be supported with support, assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated.
   3. Corrosive: Piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

K. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

L. Noise Reduction: To reduce transmission of noise in piping systems, copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

2.2 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Schedule 40 and Schedule 80 Steel Pipe

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1 - 1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe

Maximum Spans for Pipe Supported in Minimum **120 degree** contact saddles (feet)

Nominal Pipe Diameter (inches)	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	42	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	--	40	43	47	50	52	56			
45	--	40	44	47	50	53	57			
48	--	40	44	47	50	53	58	61		
51	--	41	44	48	51	53	58	62		
54	--	41	44	48	51	54	58	62		
57	--	41	44	48	51	54	59	63		
60	--	41	45	48	52	54	59	63	67	70
63	--	41	45	49	52	55	60	64	67	71

66	--	41	45	49	52	55	60	64	68	71
72	--	41	45	49	52	55	61	65	69	72
78	--	41	45	49	53	56	61	66	69	73
84	--	41	46	50	53	56	62	66	70	74
90	--	41	46	50	53	56	62	67	71	74
96	--	42	46	50	54	57	62	67	71	75

3. For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = \sqrt{\frac{7500tD}{32t + D}}$$

Where: t = Thickness (inches)
D = Diameter (inches)
L = Maximum span (feet)

4. Support Spacing for Ductile-Iron Pipe:

Normal Pipe Diameter (inches)	Maximum Span (feet)
All diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Normal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1 - 1/2	6
2 to 4	10
6 and greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4.5
1	5
1 - 1/4	5.5
1 - 1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

2.3 MANUFACTURED SUPPORTS

A. Stock Parts: Where not specifically indicated, designs which are generally accepted as exemplifying good engineering practice and use stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

B. Manufacturers, or Equal
   1. Grinnell Corp. (Supply Sales Company), Cranston, RI
   2. Power Piping Company, Pittsburgh, PA.

2.4 COATING

A. Galvanizing: Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. Other Coatings: Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 098000 – Protective Coatings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Pipe supports, seismic restraints, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ASME B31.1 - Power Piping. Concrete inserts for pipe hangers and supports shall be coordinated with the form work.

B. Appearance: Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. Hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.

3.2 FABRICATION

A. Quality Control: Pipe hangers, supports, and seismic restraints shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

END OF SECTION 400507

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400519 – DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all ductile iron pipe, fittings, transitions, connections and appurtenant work, complete and in accordance with the requirements of the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 400500 – Piping, General
B. Section 330505 – Pipeline Testing
C. Section 331400 – Hydraulic Structures Testing

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards:

ANSI/AWWA C104/A21.4	Cement-mortar lining for Ductile Iron and Gray Iron Pipe and Fittings for Water.
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Gray and Ductile Cast Iron Piping for Water and Other Liquids.
ANSI/AWWA C110/A21.10	Fittings, 3-inch through 48-inch for Water and Other Liquids, Gray Iron and Ductile Iron.
ANSI/AWWA C111/A21.11	Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
ANSI/AWWA C115/A21.15	Flanged Ductile Iron and Gray Iron Pipe with Threaded Flanges.
ANSI/AWWA C150/A21.50	Thickness Design of Ductile Iron Pipe.
ANSI/AWWA C153/A21.53	Mechanical Joints (MJ), Push-on joints.
ANSI/AWWA C151/A21.51	Ductile Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Water and Other Liquids.
ANSI/AWWA C209	Cold Applied Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
ANSI/AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines.
ANSI/AWWA C600	Water Mains and Appurtenances, Installation of Ductile Iron.
ANSI/ASTM D 1248	Polyethylene Lining Material for Ductile Iron Pipe and Fittings.
ASTM C 150	Specification for Portland Cement.
ASTM A 746	Installation of Ductile Iron Pipe for Gravity Sewers.

1.4 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications and as specified in the referenced standards. Certification shall include physical and chemical properties of pipe materials and hydrostatic test reports.

B. All expenses incurred in sampling and testing for certifications shall be borne by the Contractor.

1.5 QUALITY ASSURANCE

A. Ductile iron pipe shall be manufactured with the material, have the dimensions, be within the tolerances and meet the testing requirements set forth in ASTM A746 and ANSI A21.51. Ductile iron pipe shall be manufactured in nominal 18-foot or 20-foot laying lengths and shall have the lining called for in the Contract Documents.

B. All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.

C. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Mortar lined ductile iron pipe shall conform to ANSI/AWWA C151, C104, C105, C214 and D1248, subject to the following supplemental requirements. The pipe shall be of the diameter shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents and all specials and fittings shall be provided as required under the Contract Documents.

B. The pipe shall be handled by use of wide slings, padded cradles or other devices acceptable to the Engineer, designed and constructed to prevent damage to the pipe lining and/or coating. The use of chains, hooks or other equipment which might injure the pipe lining and coating will not be permitted. Stockpiled pipe shall be safely and properly supported to prevent accidental rolling. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

C. Maximum pipe laying lengths shall be 20-foot with shorter lengths provided as required by the Drawings.

D. The pipe shall have a smooth dense interior surface and shall be free from fractures, defects and roughness.

2.2 MATERIALS

A. Ductile iron pipe materials shall conform to the requirements of ANSI/AWWA C151/A21.51.

B. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C110/A21.10 or AWWA C153 for diameters 3-inch through 48-inch. Ductile iron fittings larger than 48-inch shall conform to the above referenced standard with the necessary modifications for the larger size.

C. Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104/A21.4; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.

E. Material for the polyethylene encasement shall conform to the requirements of ANSI/AWWA C105/A21.5.

F. All elastomer gaskets used for ductile iron pipe shall be of neoprene or SBR elastomer material with a 1/8” thickness. For high temperature service (process air) gaskets shall be Viton. For high temperature water service gaskets shall be EPDM.

G. All bolts, nuts, and washers, which are buried, submerged or below the top of the wall inside any hydraulic structure used in the assembly of ductile iron pipe and fittings shall be of Type 316 Stainless Steel.

2.3 DESIGN OF PIPE

A. Ductile iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C150/A21.50, as applicable and as modified in this Section. The pipe furnished shall be either mortar-lined or glass-lined as called out in the Contract Documents.

B. The pipe shall be designed, manufactured, tested, inspected and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C151.

C. Unless noted otherwise, the pipe and fittings shall be of the diameter shown and shall be of pressure Class 350 for pipe sizes twelve inches and below, pressure Class 250 for pipe fourteen inches to twenty inches, pressure class 200 for twenty-four-inch pipe and pressure class 150 for thirty inch and above, except that where mechanical couplings are used and the pipe is grooved, the ductile iron pipe shall be of special thickness Class 53.

D. Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints and restrained joints as required.

1. All Mechanical and push-on joints may conform to ANSI/AWWA C153/A21.53 or C110/A21.10.
2. Flanged joints shall conform to ANSI/AWWA C115/A21.15.

D. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

E. Unless noted otherwise, pipe used for hot water applications shall not have an interior lining.

2.4 CEMENT-MORTAR LINING

A. Except as otherwise provided herein, interior surfaces of ductile iron pipe, fittings and specials to be furnished with cement-mortar lining shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (inches)	Minimum Lining Thickness (inches)
3-12	1/8
14-24	3/16
30-54	1/4

C. For all pipe and fittings with plant-applied cement mortar linings, the Contractor shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.5 PIPE ENCASEMENT

A. All buried DIP shall be polyethylene encased.

2.6 EXTERIOR COATING OF PIPE

A. The exterior surfaces of ductile iron pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 098000 entitled, "Protective Coating." This exposed piping shall not be coated with the bituminous coating by the manufacturer prior to delivery.

B. Buried ductile iron pipe shall be pipe shall be epoxy-coated according to requirements of Section 098000 “Protective Coatings”.

C. Submerged ductile iron pipe shall be epoxy-coated according to requirements of Section 098000 “Protective Coatings”.

2.7 RESTRAINED JOINTS

A. Restrained joints shall conform to either ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53.

B. Restraint devices for pipe sizes 3" – 48" shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. The devices shall have a working pressure rating of 350 psi for 3"-16" and 250 psi for 18"-48". Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.

C. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536. For applications requiring restraint 30" and greater, an alternate grade of iron meeting the material requirements of ASTM A536 is acceptable, providing the device meets all end product performance requirements. Ductile iron gripping wedges shall be heat treated within a range of 370 to 470 BHN.

D. Three (3) test bars shall be incrementally poured per production shift as per UL specifications and ASTM A536. Testing for tensile, yield and elongation shall be done in accordance with ASTM E8. Chemical and nodularity tests shall be performed as recommended by the Ductile Iron Society, on a per ladle basis.

E. Mechanical joint restraint for ductile iron pipe shall be produced by EBAA Iron, Inc and shall be:

   a. Megalug Series 1100 for Fittings
   b. Megalug Series 1700 for Joints
   c. Megalug Series 3800 for Couplings

F. Finish shall be Megabond, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE

A. All pipe, fittings, etc. shall be carefully handled and protected against damage, impact shocks and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground, but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site in accordance with Paragraph 2.1B, herein. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

B. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

C. The pipe shall be installed in accordance with ANSI/AWWA C600. Before placement of the pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work. As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, rocks and any other debris following completion of pipe laying prior to testing and disinfecting the completed pipeline.

D. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent joint loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

E. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer.

F. No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

G. The openings of all pipe and specials where the pipe and specials have been cement-mortar lined in the shop shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

H. Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

I. All valves shall be handled in a manner to prevent any injury to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to ensure proper operation. All valves shall be installed so that the valve stems are plumb and in the location shown.

K. All buried bolts shall be coated with FM grease prior to applying the polyethylene wrap.

END OF SECTION 400519

SECTION 400523 - STAINLESS STEEL PIPING AND TUBING

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide stainless steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 400500 – Piping, General apply to the Work of this Section.

1.2 DESIGN REQUIREMENTS

A. Piping Layout: Layout and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints made up in the field are minimized. Piping layout shall not rely on field welding, which is prohibited except as authorized by Engineer for special circumstances.
   1. Piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every field joint and flexible coupling that may be needed to connect piping sections fabricated in the shop.
   2. Add joints and flexible couplings in a manner that achieves intent of maximizing size of individual piping sections.
   3. Obtain acceptance of Engineer for joints and connectors prior to fabrication.

B. Shop Fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

C. Field Assembly: Assemble shop-fabricated piping in the field using the joints designed into the piping layout or by using flexible couplings. Field welding is prohibited, unless written authorization is provided by the Engineer.

1.3 SUBMITTALS

A. Layout Drawings: Provide detailed layout drawings showing dimensions and alignment of pipes; location of valves, fittings, and appurtenances; location of field joints and couplings; location of pipe hangars and supports; connections to equipment or structures; location and details of shop welds; and thickness and dimensions of fittings and gaskets.
   1. Prepare layout drawings using latest version of AutoCAD.
   2. Submit AutoCAD files after layout drawings have been reviewed and accepted by Engineer.

B. Product Data: Provide the following:
   1. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
   2. Material specifications for pipe, gaskets, fittings, and couplings.
   3. Data on joint types and components used in the system including stub ends, backing flanges, flanged joints, grooved joint couplings and screwed joints.

C. Manufacturing certifications.

D. Welder and weld operator qualification certificates and welding procedures. A schedule of weld operators and identification symbols, as required in Article 2.01 F. Field welding references.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL

A. General:
 1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall Thickness:
 1. As specified in the piping schedule.

C. Piping Material and Manufacturing: Comply with the requirements outlined in the following table (unless otherwise specifically noted in the Drawings):

Service	Stainless Steel Grade	Pipe Manufacturing Process
Piping 3 inches in nominal diameter and larger	Type 316L stainless steel conforming to ASTM A 240	In accordance with ASTM A 778
Piping less than 3 inches in nominal diameter	Type 316L stainless steel conforming to ASTM A 240	In accordance with ASTM A 312

D. Fittings for Piping 3 inches in Nominal Diameter and Greater:
 1. Material: ASTM A 240 stainless steel, grade to match the pipe.
 2. Manufacturing Standard: ASTM A 774.
 3. Wall Thickness of Fitting: In accordance with ANSI B 36.19 for the schedule of pipe specified.
 4. End Configuration: As needed to comply with specified type of joint.
 5. Dimensional Standards:
  a. Fittings with Weld Ends: In accordance with ANSI B 16.9.
  b. Fittings with Flanged Ends: In accordance with ANSI B16.5, Class 150.

E. Fittings for Piping Less than 3 inches in Diameter:
 1. Material: ASTM A 240 stainless steel, grade to match the pipe.
 2. Manufacturing Standard: ASTM A 403, Class WP.
 3. Wall Thickness and Dimensions of Fitting: In accordance with ANSI B16.3 or ANSI B16.9 as appropriate and as required for the schedule of pipe specified.
 4. End Configuration: As needed to comply with specified type of joint.
 5. Forgings conforming to ASTM A182, Grade F304 or Grade F316; or barstock conforming to ASTM A276, Type 316. Forging or barstock material shall match the piping materials.

F. Piping Joints:
 1. Joint Types, Piping Greater than 2 Inches in Diameter, General:
  a. Where type of joint is specifically indicated on the Drawings or specified, design and shop-fabricate piping sections utilizing type of joint illustrated or scheduled.
  b. Where type of joint is not specifically indicated on the Drawings or specified in the Piping Schedule, design and shop-fabricate piping sections utilizing any of the following joint types:
   1) Piping stub ends with backing flanges.
   2) Welded joints.

3) Flanged joints.

c. Joints at Valves and Pipe Appurtenances: Provide flanged valves and flanged pipe appurtenances in stainless steel piping systems with flanged ends. Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using piping stub ends with backing flanges, flanged coupling adapters or flanged joints.

1) Flexible Couplings and Flanged Coupling Adapters: Provide stainless steel construction with materials matching the piping system, Dresser Industries, Style 38 or equal.

2. Joints in Piping 2 Inches in Diameter and Smaller: Flanged or screwed with Teflon tape thread lubricant.

3. Welded Joints:

a. Pipe 12 Inches and Larger in Diameter: Automatically weld joints using gas tungsten-arc procedures.

b. Piping 4 Inches Through 12 Inches in Diameter: Double butt welded joints

c. Piping less than 4 Inches in Diameter: Single butt-welded joints.

4. Flanged Joints: Conforming to the requirements of ANSI B16.5, Class 150.

5. Piping Stub Ends and Backing Flanges for Pipe 3 inches and Larger:

a. Piping Stub Ends: Cast Type 316L stainless steel to match the pipe material with machined gasket and wetted surfaces of stub ends free of crevices, pits, cracks and protrusions. Manufacturers: Alaskan Copper Works, Figure SK-38 or equal.

b. Backing Flanges: Cast or forged Type 316 stainless steel with drilled bolt patterns conforming to ANSI B16.1, Class 125 or ANSI B16.5, Class 150. Manufacturers: Alaskan Copper Works, Figure SK-39 or equal.

6. Flanges for Schedule 10s, 40s and 80S Pipe:

a. Provide forged Type 316L stainless steel welding neck flanges or slip-on flanges conforming to ANSI B16.5 Class 150.

b. Material shall conform to ASTM A182.

7. Grooved Joints: Rigid type with rolled grooves.

a. Pipe and fittings roll grooved to conform with AWWA C 220.

b. Grooving may be accomplished in factory or in field.

c. Couplings: Rigid type, cast from ductile iron, Victaulic Style 07 or equal. Coat per Section 098000 – Protective Coatings

G. Gaskets:

1. Aeration Air Service: Unless noted otherwise - EPDM, suitable for temperatures up to 250 °F, 1/8-inch thick (minimum), 60 shore hardness, smooth surface. Garlock Style 8314 or equal.

2. All Other Service Applications: EPDM, nitrile, or other materials compatible with the process fluid.

H. Bolts for Flanges and Stub End/Backing Flanges: In compliance with ASTM A193 heavy hex head. Length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut. Nuts shall comply with ASTM A194 heavy hex pattern. Bolts, nuts, and washers shall be Type 316 stainless steel.

I. Fabrication of Pipe Sections:

1. Welding: Weld in accordance with Section 05 50 00 and using electrodes and techniques in accordance with AWS D10.4.

2. Weld Seams:

a. Full penetration welds, free of oxidation, crevices, pits and cracks and without undercuts.
b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.
c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

J. Pickling and Passivation:
1. Following shop fabrication of pipe sections, straight spools, fittings and other piping components, pickle and passivate fabricated pieces.
2. Immerse fabricated pieces in sulfuric acid solution followed by immersion in a nitric-hydrofluoric bath and subsequent wash at the proper temperature and length of time.
3. Finish Requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

2.2 STAINLESS STEEL TUBING

A. Stainless Steel Tubing: Seamless tubing made of Type 316L stainless steel and conforming to ASTM A 269, wall thickness not less than 0.065 inches.

B. Fittings: Swage ferrule design with components made of Type 316 stainless steel.
1. Double acting ferrule design, providing both a primary seal and a secondary bearing force.
2. Flare, bite, or compression type fittings are not acceptable.
3. Manufacturers: One of the following or equal:
   a. Crawford Fitting Company, Swagelok.
   b. Hoke, Gyrolok.
   c. Parker, CPI.

C. Valves for Use with Stainless Steel Tubing:
1. Ball type valves with swage ends to match tubing diameter.
2. Type 316 / 316L stainless steel with TFE seats.
3. Manufacturers: Apollo, Nupro or equal.

2.3 SOURCE QUALITY CONTROL

A. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

B. Provide written certification that the pipe as supplied conforms to the requirements of ASTM A778. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied conform to the requirements of ASTM A774. Supplementary testing is not required.

PART 3 - EXECUTION

3.1 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly.

3.2 INSTALLATION

A. General: Stainless steel pipe shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. Installation shall be acceptable to the Engineer.

B. Supports and Anchors: Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 00 01 – Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

D. Protection: Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work.

1. Handling methods and equipment used shall prevent damage to the coating and shall include the use of wide canvas slings and wide padded skids.
2. Bare cables, chains, hooks, metal bars, or narrow skids shall not be used.

3.3 PIPE JOINTS

A. Threaded Joints: Pipe threads shall conform to ANSI/ASME B 1.20.1 – Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.

B. Welded Joints: Welded joints shall conform to the specifications and recommendations of ANSI/ASME B 31.1 – Power Piping. Welding shall be done by skilled and qualified welders per Section 40 05 00 – Piping, General.

1. Field welding is prohibited unless written authorization is provided. Pipe butt welds may be performed at the Site, if authorized by the Engineer, providing the butt welds are performed only with an inert gas shielded process and that other indicated welding requirements are followed rigidly.
2. Residue, oxide, and heat stain shall be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning, inside and outside of pipe, with an agent such as Eutectic Company's "Euclean" or equal, followed by complete removal of the agent.

C. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conforming to ANSI/AWWA C606. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

3.4 INSPECTION AND FIELD TESTING

A. Inspection: The finished installation shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.

B. Field Testing: Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.
2. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

END OF SECTION 400523

SECTION 400533 - HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall provide high density polyethylene pipe and appurtenances, complete in place, in accordance with the Contract Documents.

1.2 RELATED SECTION

A. Section 312000 – Earth Moving

1.3 REFERENCES

A. The Materials and Work furnished shall be, as a minimum, in accordance with the latest editions of the following standards except as such Standard are modified and supplemented in this section.

AWWA C906	Standard for Polyethylene (PE) Pressure Pipe & Fittings, 4 inch (100 mm) through 63 inch (1,575 mm) for Water Distribution and Transmission
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM D3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM D256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM F1055	Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
ASTM D2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM F2164	Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure

ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
PPI TR-33	Generic Butt Fusion Joining Procedure for Field Joining of PE Pipe

1.4 SUBMITTALS

A. The Contractor shall submit the following information and data. See Section 013300 – Contractor Submittals.

1. Product Data: Provide data indicating pipe, pipe accessories and fittings.
2. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.
3. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
4. Certified Resin Test Reports covering the physical, stress, regression, thermal and impact tests of resin material to be used for the pipe. Submit this information prior to manufacturing or fabricating any pipe.
5. Proposed butt fusion procedures including training and qualification requirements and joint repair procedures shall be submitted to the Engineer for review and approval.
6. Qualifications of Butt Fusion Welders and Welding Operators
   a. All butt fusion welders and welding operators shall be qualified and certified for all portions of the work specified in this section. Welder qualification requires that during the past 12 months all welders and welding operators have successfully completed certified butt-fusion joints using the pipe and welding machine proposed for this project.
   b. Current welder and welding operator performance qualification test records shall be submitted to the Engineer for review and approval prior to commencing field operations.
   c. Personnel that will be operating the butt fusion welder shall be certified by either 1 and 3, or 2 and 3 of the following criteria:
      1) Previous demonstrated experience during the past 12 months, in the use of the procedure on similar projects using the same welding machines and type of pipe proposed.
      2) Appropriate training and apprenticeship
      3) All operators shall make a specimen joint from the pipe to be used on the project. This joint shall then be subjected to the test requirements specified herein.
7. Fusion parameters including the recommended limits of all criteria recorded by the data logger.
8. Fusion report for each joint, which shall include the following information.
   a. Pipe size and dimensions
   b. Machine size
   c. Operator identification
   d. Job identification number
   e. Weld number
   f. Fusion, heating and drag resistance settings
   g. Heater plate temperature
   h. Time Stamp
   i. Heating and curing time of weld
   j. Curing temperature readings and time stamps of readings
   k. Ambient air temperature and humidity

l. Error message and warnings for out of range temperature or pressure settings.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable codes for materials and installation of the Work in this Section.

1.6 PROJECT CONDITIONS

A. Coordinate the Work on existing utility lines and connections to existing utility lines with the Owner.

1.7 QUALITY CONTROL

A. Any pipe manufactured prior to review and approval of all required prefabrication submittals will be at the Contractor's own risk.

B. Review of the Contractor's shop drawings shall not relieve the Contractor of any responsibility for accuracy of dimensions and details, nor shall mutual Agreement of dimensions or details relieve the Contractor of responsibility for Agreement and conformity of its Shop Drawings with the Contract.

1.8 QUALITY ASSURANCE

A. Fabrication, processing, testing and inspection operations affecting the pipe and associated accessories shall, at any time, be subject to quality assurance surveillance by Owner, or Engineer. Such surveillance shall be at the discretion of the Owner. Such surveillance does not relieve the Contractor from responsibility for the Work.

B. All deviations from this specification section must be documented and referred to Engineer for resolution.

C. The Contractor shall submit to the Engineer an affidavit from the manufacturer that the pipe, specials, fittings, and other products of material furnished under this Contract comply with all applicable provisions of AWWA C906 standards and this specification.

D. DOCUMENTATION: The following items shall be documented and stored as part of the manufacturer's permanent records. Copies of all documentation shall be provided to the Engineer.

1. Documentation from the resin's manufacturer showing results of the following tests for resin identification:
    a. Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer, ASTM D1238
    b. Standard Test Method for Density of Plastics by the Density - Gradient Technique, ASTM D1505
2. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined in accordance with ASTM D2837.

3. Production staff shall check each length of pipe produced for the items listed below. The results of all measurements shall be recorded on production sheets, which becomes part of the manufacturer's permanent records.
    a. Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc.)
    b. Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM D3035.
    c. Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM D3035.
    d. Pipe length shall be measured.
    e. Pipe marking shall be examined and checked for accuracy.
    f. Pipe ends shall be checked to ensure they are cut square and clean.
    g. Subject inside surface to a "reverse bend test" to ensure the pipe is free of oxidation (brittleness).
    h. Copies of all manufacturer documentation shall be submitted to the Engineer for review and approval upon completion of manufacturing.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished as a part of the Work.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Contractor shall comply with the following minimum requirements:
  1. Referenced standards for all materials, processes, methods, tests, etc to be used in completion of the Work.
  2. Delivery of all pipe and materials, all aspects of which shall be conducted in such a manner as to minimize handling, provide proper weather protection and storage, and to meet schedule requirements.
  3. Furnish and use load rated nylon-type slings for securing, lifting, and unloading pipe sections; or, the use of acceptable protective wraps to minimize damage from the alternate rigging equipment.
  4. Internal timber bracing shall be provided to maintain pipe shape and integrity throughout plant storage, transportation, and site storage operations through installation and backfill placement. Internal bracing shall not be removed until a minimum of 2 feet of compacted trench zone material is placed above the top of the pipe.

2.2 MANUFACTURER

A. All HDPE pipe and HDPE fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications. Qualified manufacturers shall be: PLEXCO Division of Chevron Phillips Chemical Company, DRISCOPIPE as manufactured by Chevron Phillips Co., Inc., WL Plastics or equal.

2.3 PIPE IDENTIFICATION

A. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5-feet:
   1. Name and/or trademark of the pipe manufacturer.
   2. Nominal pipe size.
   3. Dimension ratio.
   4. The letters PE followed by the polyethylene grade in accordance with ASTM
   5. D1248 followed by the hydrostatic design basis of 1600 psi, e.g., PE 4710.
   6. Manufacturing standard reference, e.g., ASTM D-3035, as required.
   7. A production code from which the date and place of manufacture can be determined.
   8. Color Identification, either striped by co-extruding longitudinal identifiable color markings or shall be solid in color and as follows:
      a. BLUE – Potable Water
      b. GREEN – Sanitary Sewer
      c. PURPLE – Non-Potable (Recycled) Water

B. Marking Tape: Marking tape shall be provided and installed as shown in Drawings and per Engineer approval.

2.4 COMPATIBILITY

A. Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

2.5 WARRANTY

A. The pipe Manufacturer shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the Owner. The Manufacturer shall replace at no expense to the Owner any defective pipe/fitting material including labor within the warranty period.

2.6 MATERIALS

A. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 4710 high density polyethylene resin compound meeting a minimum cell classification 445574C per ASTM D3350 and ASTM F714.

B. High Density Polyethylene (HDPE) pipe shall be manufactured in accordance with AWWA C901-96 for sizes ½-inch through 3-inch diameters and to the requirements of ASTM D 3035. Pipe 4-inches and above shall be manufactured to the requirements of ASTM F714 and AWWA C906-99.

C. Unless otherwise noted, diameters shown in the Contract Documents shall refer to Iron Pipe Size (IPS) system conforming to the requirements of AWWA C906.

D. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used. Clean rework material of the same type grade, and cell classification generated from the manufacturers own pipe and fitting production may be used by the same manufacturer as long as the pipe, tubing and fittings produced meet all requirements of AWWA C906.

E. Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a range of density 0.956-0.964 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi at 73.0°F in accordance with ASTM D2837.

F. The extruded pipe shall have impact strengths greater than 42 in-lb/in in accordance with ASTM D256 Method A, with a material thickness representative of the cross-section in which the material is to be used.

G. Pipe and fitings used for potable water applications shall be NSF 61 certified.

H. The pipe Manufacturer shall certify compliance with the above requirements.

2.7 FABRICATION

A. Pipe shall be homogenous throughout and uniform in color, opacity, density and other properties as prescribed in the Resin Manufacturers Specifications. The inside and outside surfaces shall be semi-matte to glossy in appearance and free from sticky or tacky material. The pipe walls shall be free from cuts, cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the naked eye that may affect wall integrity.

B. Pipe dimensions and wall thickness variations shall be in conformance with requirements of AWWA C906.

C. Pipe shall be finished smooth throughout all inside surfaces and true to all specified tolerances circumference and diameter such that: The difference between maximum and minimum diameters, at any cross-section along the length of the pipe does not exceed 1% of the nominal diameter.

D. Special pipe sections, fittings, and special pieces shall be completely fabricated in the shop. All pipe fittings shall be fabricated or molded to correct dimensions throughout the entire length. Ends cuts shall be clean, squarely-made, and suitable for field welding, without drawn, ragged, gouged, or split ends.

E. All HDPE fittings, unless noted otherwise on the drawings shall be fabricated in conformance with the requirements of AWWA C906. Molded fittings shall meet the requirements of ASTM D3261 for butt-type fittings and this specification.

2.8 FITTINGS

A. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.

B. Polyethylene fittings furnished under this specification shall be manufactured using compounds complying with the requirements of HDPE pipe above and all appropriate requirements of AWWA C906. Socket fittings shall comply with ASTM D2683, Butt Fusion fittings shall comply with ASTM D3261. Electrofusion fittings shall comply with ASTM F1055. Mechanical fittings (e.g. back-up rings, etc.) shall be of stainless steel, including stainless steel hardware, as indicated in the drawings and shall be approved only after submission of appropriate test data and service histories indicating their acceptability for intended service. In all cases, the specification and requirements for the fittings supplied shall comply with the appropriate sections of AWWA C906 and must be approved by the Engineer. NO size on size wet taps shall be permitted.

C. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.

2.9 SHIPPING, STORAGE & HANDLING

A. All materials shall be properly loaded so that they will not bear on each other, and shall be braced to prevent damage to material during shipping. Pipe shall be stacked on level ground and per the manufacturer's recommendations to prevent pipe from becoming out of round.

B. All loose parts shall be crated or boxed for shipping, appropriately identified and shipped with the associated pipe sections.

C. Contractor shall protect pipeline sections stored at the site from damage, including weather and vandalism.

D. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe OR on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. The Contractor shall abide by the required handling techniques specified by the Supplier.

E. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects

F. All piping products shall be kept free from dirt, grease, all petroleum based products, and other foreign matter.

G. The Contractor shall provide suitable lifting equipment, slings, spreader bars, rigging etc needed to handle the pipe. In no case shall any equipment be used that is not rated to handle the intended loading or conditions of use to which it is subjected. The use of cables and chains is prohibited.

H. The Contractor shall be responsible for the pipe until such time as it is installed and accepted by the Engineer.

I. The Contractor shall remove any temporary attachments to special components for installation by the Supplier for transportation purposes.

2.10 BEDDING AND COVER MATERIALS

A. Pipe bedding Material: As specified in Section 312000 – Earth Moving.

PART 3 - EXECUTION

3.1 INSTALLATION – HDPE PIPING

A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instructions of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.

B. Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon “pull-back”.

C. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches. Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined. Repair of damaged pipe during or after installation shall conform to the fabricator’s repair procedures or by an Engineer approved repair method.

D. When laying pipe is not in progress, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means.

E. The interior of the pipe shall be cleaned of any foreign matter before being lowered in the trench and kept clean during placement, joint welding, bedding and backfilling operations by plugging or other approved method. Groundwater shall not be permitted to enter the pipe. The full length of each pipe section and each bend shall rest solidly on the compacted bedding material.

F. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

G. If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

H. Contractor shall install HDPE pipe when the ambient air temperature conforms to manufacturer’s specifications. The Contractor will be responsible for verifying the temperature by maintaining a log listing dates, times, length of pipe installed and ambient temperature during installation.

I. Trench bottoms shall be graded such that each section of pipe shall be placed to the specified depth or elevation with uniform support. When the bottom of the trench has been excavated below the specified depth or elevation it shall be brought to the specified depth or elevation by backfilling with approved pipe zone material. When material at the bottom of the trench is determined to be unsuitable by the Engineer, it shall be removed and the trench backfilled with approved subgrade material or bedding material to the specified depth of excavation.

J. During pipe installation, the trench bottom shall be kept free of frost, frozen earth, or standing water. The Contractor shall maintain the trench in good, stable condition at all times to prevent caving.

K. Precautions shall be taken to prevent flotation of the pipe in the trench.

L. The pipeline may be buried as it is installed, provided all inspection, testing and backfill requirements are met.

M. All areas disturbed by installation of the pipeline shall be restored in accordance with the specification and drawings.

3.2 JOINING METHOD

A. HDPE pipe shall be joined with butt, heat fusion joints as outlined in ASTM D3261 and conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33, published by the Plastic Pipe Institute (PPI). All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the Inspector. The Contractor shall install the HDPE pipeline complete, including bends, couplings, valves, and other associated fittings and appurtenances as shown on the drawings or specified herein and make all necessary connections to the lines and grades shown on the Drawings and in accordance with these specifications.

B. The Contractor shall furnish all welding equipment and all construction materials and equipment required for lugs, railings, templates, spiders or other supports and internal bracing as may be required to hold the components firmly within the specified tolerances during welding, concrete placement or backfill placement. The contractor shall also furnish and install all necessary positioning devices, ties, pedestals and supports required for installation. Details of such equipment shall be included in the proposed installation procedure to be submitted to the engineer prior to the start of work.

C. Lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process. All pipes so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet. Installation shall be in accordance with the requirements of AWWA C906 unless otherwise noted, and the Manufacturer's instructions. Contractor shall be responsible for correct fitting of all pipeline members and components.

D. The polyethylene flange adapters shall be used at pipe material transitions and other locations as indicated in the drawings. The adapters shall be connected together or to other flanges by using a stainless steel "back-up" ring conforming to ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe. Ensure that back up rings are in place prior to joining flange adapter to piping or other components. The flange adapter assemblies shall be connected with corrosion resistant bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer's specified torques. Bolts shall be tightened alternatively and evenly. After installation apply a non-oxide grease coating to bolts and nuts.

E. Where indicated, sleeve couplings shall be used to make HDPE joints. When sleeve couplings are used, stainless steel (Type 316), pipe stiffeners shall be inserted inside of each HDPE pipe end as recommended by the manufacture to prevent the pipe from going out of round and to ensure a leak free joint. Sleeve couplings shall be specifically rated for service with HDPE pipe and shall be as specified in the Contract Documents. Sleeve coupling shall only be used where indicated in the plans and in conjunction with an HDPE Pipe Anchor Block.

3.3 PREPARATION

A. Butt-fusion welded joints: Refer to Manufacturers recommended procedures. All joints formed by butt fusion processes shall be completed in strict accordance with the Manufacturers specified procedures, except where specifically called out in the specifications or drawings. Minimum requirements for butt-fusion welded joints are as follows:
   1. Pipe ends shall be made clean and square prior to fitting and alignment
   2. Care shall be taken to assure a clean work area, free from airborne dust, moisture, or other foreign matter which may contaminate the finished weld.
   3. All internal surfaces of the pipe shall be maintained clean following completion of a weld and prior to starting the next joint.
   4. All butt-fusion joints shall be water tight under the maximum internal pressure.

3.4 BACKFILL PLACEMENT

A. Pipe zone material shall be placed in accordance with Section 312000 – Earth Moving. Care shall be taken to ensure that the material is carefully worked and compacted into the area beneath and around the pipe to provide continuous support to the pipe. Material shall be properly haunched to provide support. Care shall be taken to avoid movement of the pipe during placement and compaction of the bedding material. Pipe bedding shall be placed to the limits shown on the drawings.

B. Trench backfill shall be placed in accordance with section 312000 – Earth Moving.

C. No construction vehicles or ride-on mechanical compaction equipment shall be permitted to travel over the pipe until a minimum of 2 feet of trench backfill is placed above the top of the pipe.

3.5 CONNECTION TO EXISTING

A. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consists of the following:
   1. A polyethylene flange adapter shall be thermally butt-fused to the stub end of the pipe.
   2. A Type 316 stainless steel back up ring shall mate with the polyethylene flange adapter.
   3. Type 316 stainless steel bolts and nuts shall be used to complete the connection.
   4. Flange connections shall be provided with a full-face neoprene gasket.

B. All transitions from HDPE pipe to ductile iron or PVC shall be made per the approval of Engineer and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector adapter with a back-up ring assembly shall be used for pipe type transitions. Ductile iron back-up rings shall mate with cast iron flanges per ANSI B16.1. A type 316 stainless steel back-up ring shall mate with a type 316 stainless steel flange per ANSI B16.1 and shall be used in all buried applications.
   1. Transition from HDPE to ductile iron fittings and valves shall be approved by Engineer before installation.
   2. No solid sleeves couplings shall be allowed between such material transitions.
   3. The pipe supplier must certify compliance with the above requirements

C. Prior to making connections to any existing structure or pipe, ensure that new pipe has had the time required to acclimate to the buried conditions. Make the appropriate adjustments required by the thermal expansion and contraction properties of HDPE materials before connecting to any dissimilar material or structure.

3.6 FIELD QUALITY CONTROL

A. On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of the Inspector. The following shall apply:
   1. Heating plates shall be inspected for cuts and scrapes. The plate temperature shall be measured at various locations to ensure proper heating/melting per manufacturer's recommendations and as approved by the Inspector.
   2. The fusion or test section shall be cut out after cooling completely for inspection.
   3. The test section shall be 12" or 30 times (minimum) the wall thickness in length and 1" or 1.5 times the wall thickness in width (minimum).
   4. The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e. – joint shall have visible molded material between walls of (pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16" to a maximum 3/16".

3.7 TOLERANCES

A. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-in per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed. Good alignment shall be preserved during installation. Deflection of the pipe shall occur only at those places on design drawings and as approved by the Engineer. Fittings, in addition to those shown on the Drawings, shall be used only if necessary or required by the Engineer.

3.8 CLEANING

A. Do not allow dirt, grease, mud, groundwater, tools, equipment and all other foreign matter to enter the pipe at any point during construction.

B. All pipes shall be completely flushed at a rate with water velocities no less than 4.0 feet per second for pipes up to 12 inches in diameter and 3.0 feet per second for all other pipes. For large diameter pipes, alternate methods, including pigging, of cleaning the pipe may be proposed by the Contractor, subject to the approval of the Engineer, provided proposed method will provide a clean pipe equivalent to flushing as determined by the Engineer.

C. No debris, rubbish, dirt, rocks, or other foreign material shall be permitted to enter downstream sections of the pipeline or system.

D. Furnish, install and permanently remove all cross-connections, piping, valving, ports, etc required to complete the cleaning process. Obtain approval of the Engineer prior to adding any components to the pipeline.

3.9 HYDROSTATIC PRESSURE TESTING

A. Hydrostatic pressure testing shall be conducted per the requirements of ASTM F 2164 and these specifications.

B. All HDPE mains shall be field-tested. Contractor shall supply all labor, equipment, material, gages, pumps, plugs, meters and incidentals required for testing. Each main shall be pressure tested upon completion of the pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.

C. Submit a plan for testing, including schedule, method for water conveyance, control, and disposal, to the Engineer for review at least 10 days before starting the test and notify the Engineer a minimum of 48 hours prior to test

D. The maximum test pressure shall be as indicated in the Drawings but shall not exceed 150 percent of the maximum working pressure of the pipe or the design pressure of any component on the pipe, whichever is less.

E. The test temperature of the piping and the test liquid (water) shall not exceed 73 degrees F. or the temperature related to the pressure rating of the pipe as reported by the manufacturer.

F. Test equipment, preparations and procedures shall implicitly follow the requirements of ASTM F 2164 and the Manufacturer's recommendations.

G. In preparing for test, fill line slowly with water. Maintain flow velocity less than 2 feet per second or less than the capacity of any air release devices use to expel trapped air, whichever is less.

H. Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation. Any taps installed solely for the purpose of releasing trapped air shall be permanently capped at the conclusion of the test.

I. Once all air is expelled and all testing equipment and pipeline components are adequately braced, gradually increase the pressure in the pipeline to the required maximum test pressure. Hold test pressure for four hours adding make-up water as required to maintain the noted maximum test pressure.

J. After the four hour equalization period, reduce pressure in the pipeline by 10 psi to the test pressure and monitor the pressure for 1 hour. Do not increase the pressure or add make-up water during this time.

K. During and after the one-hour test period, observe all components, joints, fittings, and appurtenances of the pipeline for visible signs of leakage. Any visible signs of leakage indicate a failed test, all such leaks shall be repaired and pipeline retested before pipeline will be accepted. If any visible signs of leakage in any butt-fusion joints in the pipe are noted, immediately stop the test and carefully release the test pressure. Repair the noted leaks and restart test procedure from beginning.

L. A successful hydrostatic pressure test will be indicated by no visible signs of leakage and a steady pipeline pressure within 5 psi of the test pressure throughout the one hour test period without increasing the pressure or the addition of make-up water.

M. Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the Engineer at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the Engineer.

N. Repair and/or replace any failed pipeline sections, components, fittings, valves or other appurtenances to the satisfaction of the Engineer and at no additional expense to the Owner.

3.10 LOW PRESSURE AIR TESTING

A. HDPE pipelines intended for use as air ducts shall be tested for leakage prior to placing the pipe in service. Air test shall not be used for acceptance of any HDPE pipeline except those indicated herein or in the Drawings. Furnish, install and completely remove all fittings, branches, plugs, valves and other appurtenances required to complete the testing process.

B. Prior to beginning air test, HDPE pipeline shall be isolated from pipeline components not rated for the air pressures called for in the test.

C. Low pressure air testing shall be completed per the requirements of ASTM F1417 as given in Section 221066 – Pipeline Testing.

D. Pipeline shall be inspected for all visible infiltration leaks as evidenced by infiltrating groundwater. Leaks shall be located and repaired at no additional cost to the Owner and to the satisfaction of the Engineer.

3.11 MANDREL TESTING

A. After successful completion of hydrostatic test, mandrel test all buried HDPE piping.

B. Mandrel configuration: Rigid with circular cross-section with a diameter of not less than 95% of the average inside diameter of the pipeline with a length of circular proportion equal to the nominal diameter of the pipeline.

C. Mandrel pulling method shall be by hand, rope or as directed by the Engineer.

END OF SECTION 400533

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400557 – ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.

D. Single Manufacturer: Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Section 260000 - Electrical General Provisions apply to the Work of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300 – Contractor Submittals.

B. Shop Drawings: Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.

C. Calculations: Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.

D. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, butterfly valve manual actuators, and butterfly valve electric motor actuators under one cover and in accordance with the requirements of Section 013300 – Contractor Submittals.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The Contractor shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.

B. Manufacturers: Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are furnished by different manufacturers, the Contractor shall coordinate selection to have the fewest number of manufacturers possible.

C. Materials: Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.

D. Actuator Mounting and Position Indicators: Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.

E. Standard: Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C 540 - Power-Actuating Devices for Valves and Slide Gates.

F. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with the power requirements of Division 26.

G. Fasteners: Fasteners shall be in accordance with Section 055000 – Metal Fabrications.

H. Protective Coatings: Protective coatings shall be in accordance with Section 098000 – Protective Coatings.

2.2 MANUAL ACTUATORS

A. General: Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4-inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psi, valves 30-inches in diameter and larger, and where so indicated, shall have worm gear actuators, hermetically-sealed water-tight and grease-packed. Other valves 6-inches to 24-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves: Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as required by the local Utility Company or the Engineer. Wrench nuts shall comply with AWWA C 500 - Metal - Seated Gate Valves for Water Supply Service.

C. Chain Actuator: Manually-activated valves with the stem located more than 7-feet above the floor or operating level shall be provided with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains provided by the valve manufacturer. The wheel and guide shall be of ductile iron, cast iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5-feet 6-inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

D. Floor Stands: Valve actuator floor stands shall be cast iron or fabricated steel pedestals. The centerline of the actuator shall be approximately 42 to 48 inches above the base of the pedestal.

E. Floor Boxes: Hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

F. Tee Wrenches: Buried valves with floor boxes shall be furnished with 2 operating keys or 1 key per 10 valves, whichever is greater. Tee wrenches sized so that the tee handle will be 2 to 4 feet above ground, shall fit the operating nuts.

G. Manual Worm Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90 degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears or worm gearing. The gear ratio shall be self-locking to prevent "back-driving." The spur or helical gears shall be of hardened alloy steel and the worm gear shall be alloy bronze. The worm gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. Gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Output shaft end shall be provided with spline to allow adjustable alignment. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. Gearing shall be designed for a 100 percent overload. The entire gear assembly shall be sealed weatherproof. Manual worm gear actuators shall be Auma GS Series, Limitorque HBC Series, no “Or-Equals”**.**

H. Traveling-Nut Actuator: The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weatherproof cast iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of nipples. Gearing shall be designed for a 100 percent overload.

I. Schedule for Manual Actuator Types: For a complete schedule of manual actuators required on project valves (4” diameter and larger), see Valve Schedule Drawings.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adapter piece.

2. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4X assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm gearing. The spur or helical gears shall be of hardened alloy steel, and the worm gear shall be alloy bronze. Gearing shall be accurately cut with hobbing machines. Power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.
3. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.
4. Switches
    a. Electronic Type Switches: Limit switches or valve position shall be sensed by a 15 bit, optical, absolute position encoder. The open and closed positions shall be stored in a permanent, non-volatile memory. The encoder shall measure valve position continuously, including both motor and hand wheel operation, with or without use of battery. An electronic torque sensor shall be furnished. The torque limit may be adjusted from 40 to 100 percent of rating in 1 percent increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a “jammed valve” protection feature with automatic retry sequence shall be incorporated to de-energize the motor if no movement occurs. Valve actuators with electronic type switches shall be as manufactured by Limitorque or Auma Actuators, Inc.
    b. The actuator shall be wired in accordance with the schematic diagram. Wiring for external connections shall be connected to marked terminals. One of 1-inch and one of 1.25-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Switches shall not be subject to breakage or slippages due to over-travel. Traveling-nuts, cams, or micro switch tripping mechanisms shall not be used. Limit switches shall be of the heavy-duty open contact type with rotary wiping action.
5. Handwheel Operation: A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb.ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel. A clutch lever shall be provided to put actuator into handwheel operation. Valves with electric motor actuators having stems more than 7-feet above the floor shall be provided with chain activator handwheels. The clutch lever shall be provided with a cable secured to the chain to allow disengagement for manual operation.
6. Motor: The motor shall be of the totally enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480 volt, 3-phase 60 Hz current or 120 volt, 1-phase 60 Hz current as indicated on drawings, and have Class H insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 55 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10

percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. Bearings shall be of the ball type, and thrust bearings shall be provided where necessary. Bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. Two Class B thermal contacts or solid state thermistors imbedded within the motor windings shall be provided to protect against over-temperature damage. The motor shall be provided with a space heater unless the entire actuator is a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion. Each electric motor actuator shall be provided with a local disconnect switch or circuit breaker to isolate power from the motor and controller during maintenance activities.

7. Open/Close Operating Speed: Unless otherwise indicated, electric actuators shall provide a full close to full open or full open to full close operating time range from [30 to 60 seconds].
8. Schedule for Electric AC Actuator Type: For a complete schedule of electric actuators required on project valves (4" diameter and larger), see Mechanical Schedule Drawings.
   a. All electric actuators identified as "OPEN/CLOSE ELECTRIC" in Schedules, shall have AC Reversing type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
   b. All electric actuators identified as "MODULATING ELECTRIC" in Schedules, shall have AC Modulating type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
9. Remote Actuator Control Station. Valves with electric motor actuators where the valve centerline is located at a height greater than 6.5-feet above the floor shall provide a remote actuator control station at a location no higher than 4-feet above the floor. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications. The actuator controls shall be wall-mounted beneath the valve at a location approved by the Design Engineer.

B. Electric Motor Actuators (AC Reversing (Open / Close) Control Type)

1. General: Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with open / stop / close and local/off/remote selector switches on the actuator local control station.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 480 volt, 3-phase, 60 Hz current or 120 volt, 1-phase, 60 Hz current as indicated on the drawings. A control power transformer shall be included to provide a 120 volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The

integral weatherproof compartment shall contain a suitably sized 120 volt ac, single phase, 60 Hz space heater to prevent moisture condensation on electrical components. A local power disconnect switch shall be provided with each actuator. A close-coupled, padlockable switch shall be provided with each actuator.

4. Local Control Station: Each actuator shall be provided with a local control station with the valve actuator assembly. The station shall include open, close, and stop push buttons, and a local/remote selector switch.
5. Manufacturers:
   a. Auma, SA Series (for valves 12 inches and smaller) or SA with GS worm gear (for valves 14 inches and larger).
   b. Limitorque, MX/QX Series
   c. Rotork, IQ3 Series
   d. No “Or-Equals” allowed.

C. Electric Motor Actuators (AC Modulating Control Type)

1. General: Where indicated, modulating electric motor actuators shall be the AC modulating type complete with a local control station with power disconnect switch or circuit breaker, provided with open/stop/close and local/off/remote selector switches on the actuator local control station, and open/close status lights.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Control Module: The control module shall be of the electronic solid-state ac type with control outputs for positioning the valve via 4 - 20 ma input signals.
4. Starter: The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications. Power supply shall be 480 volt, 3 phase, 60 Hz or 120 volt 1-phase, 60 Hz as indicated on the drawings. A disconnect switch shall be included with each actuator. The assembly shall be rated for 100% duty continuous operation.
5. Construction: The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and pushbutton calibration elements for field setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 - 20 ma. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate of 600 starts per hour at the 50 percent to 85 percent travel range of the valve. The system shall allow control of the open, close, or percent open function when the local/off/remote switch is in the remote position. Each actuator shall have a frequency shut down system which when pre-programmed, shall function as directed upon receipt of an ESD signal.
6. Manufacturers:
   a. Auma, SA Series (for valves 12 inches and smaller) or SA with GS worm gear (for valves 14 inches and larger).
   b. Limitorque, MX/QX Series

c. Rotork IQ3 Series
d. No "Or-Equals" allowed.

D. 120 VAC Quarter-Turn and Multiturn Electric Valve Operators on Isolation Valves 3-Inch Dia. and Smaller. Where indicated on Contract Drawings, and primarily on vendor supplied equipment skids and control packages, 120 VAC electric actuators may be supplied on smaller valves of 3-inch diameter and smaller, as follows:
1. Provide 120 VAC, 1-phase motor-operated valve operator suitable for use with quarter-turn ball valves, multiturn diaphragm valves, and multiturn globe valves. Operator shall have the following characteristics and features:
a. Reversing capacitor-start motor rated for operation on 120 V ac, 60 Hz, single phase. Output torque as required for valve application and pressure differential.
b. Integral motor overload protection, with auto reset
c. Permanently-lubricated gear train
d. For open/close control, provide four single pole, double throw cam actuated limit switches (2 OPEN, 2 CLOSED). One set of limit switches shall be used for both motor control and local indication. The other set shall be available for connection to remote monitoring. Limit switch contacts shall be adjustable and shall be rated for not less than 5 amps at 120 V ac.
e. Local Control Station: Open/Close: Corrosion-resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection and 2 pushbuttons, OPEN and CLOSE. In addition, provide OPEN and CLOSE indicating lights operating at 120 V ac for connection to valve control limit switches.
f. For modulating control, provide an electronic positioner and feedback potentiometer. The positioner shall utilize a 4 - 20 ma signal to adjust the valve opening. Feedback potentiometer shall be 0 - 1000 ohms.
g. Local Control Station Modulating: Corrosion resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection, one OPEN and one CLOSE push buttons, a resistance to current converter with 4 - 20 ma output, and a 0 to 100 percent electronic valve position indicator.
h. Local power disconnect switch (NEMA 4X) for disconnecting 120 V ac power to valve. Disconnect shall be installed in the field within sight of the valve actuator, in accordance with the requirements of NPFA 70.
2. See Drawings for control diagram wiring interface.
3. Two wire control systems are not required for this actuator.
4. Operators shall be RCS, Asahi/America Quarter Master or equal.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments: Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

A. Valve and gate actuators and accessories shall be installed in accordance with Section 400551 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

B. Inspection, Startup, and Field Adjustment: An authorized representative of the manufacturer shall visit the Site and witness the following:

1. Installation of the equipment for not less than two (2) Work Days
2. Inspection, checking, and adjusting the equipment for not less two (2) Work Days.
3. Startup and field-testing for proper operation for not less than two (2) Work Days.

C. Instruction of Owner's Personnel: The authorized service representative shall visit the Site for not less than 2 Days to instruct the Owner's personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.

END OF SECTION 400557

SECTION 400561 –GATE VALVES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve.

B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts list for each type of valve. Include this data, product data, shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.2 QUALITY ASSURANCE

A. Supplier shall have at least ten (10) years' experience in the manufacture of gate valves utilizing elastomer cartridge seats, and shall provide references and a list of installations upon request.

B. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

C. Codes and Standards:
   1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
   2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".

PART 2 - PRODUCTS

2.1 RESILIENT WEDGE GATE VALVES

A. Resilient wedge gate valves shall meet or exceed all applicable requirements of current revision of ANSI/AWWA C515. They shall be UL listed, FM approved and certified to ANSI/NSF 61 & 372.

B. Valves shall have an AWWA/UL/FM 350 psig working pressure. Each valve shall be factory seat tested to 525 psig and shell tested to 700 psig. The following end types are available: MJ x MJ, FL x FL, FL x MJ, SO x SO, FL x SO.

C. Valve type shall be NRS (non-rising stem).

D. Valves shall have an arrow cast on the operating nut or hand wheel showing opening direction. The direction of opening shall be as specified by owner.

E. Valves shall be provided with a 2" square operating nut. The bolt that attaches the operating nut to the stem shall be recessed into the operating nut so as not to interfere with valve wrench operation. Bolt shall be stainless steel.

F. Valves shall have Type 316 stainless steel bolts and nuts for the stuffing box and bonnet.

G. Valve stems shall have “anti-friction” thrust washers, one above and one below the stem thrust collar to reduce operating torque. Valve stem design shall be such that if excessive input torque is applied, stem failure shall occur above the stuffing box at such a point as to enable the operation of the valve with a pipe wrench or other readily available tool.

H. Valve stems shall be made of bronze ASTM B138 alloy C67600 H04 hard bar stock material. The bronze stem collar is to be hot forge upset; collars not integral with the stem are not acceptable. The stem material shall provide a minimum 73,000 psi tensile strength, yield strength of 48,000 psi and 8% minimum elongation. Optional bronze stems materials may be ASTM B98 alloy C66100 H02 (half hard).

I. Valves shall have a stuffing box with bolts in line with flow and be O-ring sealed. Stuffing box shall have two integrally cast lifting lugs. Two O-rings shall be placed above and one O-ring below the stem thrust collar. The thrust collar shall be factory lubricated. The thrust collar and its lubrication shall be isolated by the O-rings from the waterway and from outside contamination providing permanent lubrication for long term ease of operation. Valves without a stuffing box are unacceptable. Valves without at least three stem O-rings are also unacceptable.

J. The valve body, bonnet, stuffing box and operating nut shall be composed of ASTM A536 ductile iron. The body and bonnet shall adhere to the minimum wall thickness as set forth in AWWA C515-09 Table 2, section 4.4.1.2. Wall thicknesses that do not meet AWWA minimums are not acceptable.

K. The valve disc and guide lugs shall be composed of ASTM A126 Class B or ASTM A536 ductile iron and fully encapsulated in SBR ASTM D2000 rubber. Guide caps of an acetal bearing material shall be placed over solid guide lugs to prevent abrasion and to reduce the operating torque. Guide lugs placed over bare metal are not acceptable. EPDM ASTM D2000 shall be available as an option.

L. Valves shall have all internal and external ferrous surfaces coated with a fusion bonded thermosetting powder epoxy coating of 10 mils nominal thickness. The coating shall conform to AWWA C550.

M. Tapping valves shall have an inlet flange conforming to ANSI B16.1 Class 125 for attachment to a tapping sleeve or cross. In addition, the valve inlet flange shall have a machined projection or raised alignment lip complying with MSS SP-60 for accurate alignment to the mating recess in the tapping sleeve flange. The seat opening of the tapping valves shall be at least .30” or larger than the nominal pipe size to permit full size shell cutters.

N. Valves shall be warranted by the manufacturer against defects in materials or workmanship for a period of ten (10) years from the date of manufacture. The manufacturing facility for the valves must have current ISO certification.

O. NRS valves shall be MUELLER A2361 series or approved equal.

P. NRS tapping valves shall be Mueller T2361 series or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valve shall be installed in accordance with manufacturer's written Installation and Operation Manual and approved submittals.

B. Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

C. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

D. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

B. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

3.4 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION 400561

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400562 - PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide plug valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 400557 - Valve and Gate Actuators apply to this Section.

C. Plug valves shall have undergone a proof-of-design test to demonstrate that the valve components operate at the service flow, pressure, temperature, and fluid conditions, free from binding, excessive noise, and premature failures. Proof-of-design test results shall be available to the Engineer on request. The proof-of-design test shall be conducted in accordance with the applicable provisions of AWWA C517.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300.

PART 2 - PRODUCTS

2.1 GENERAL

A. Plug Valves shall be quarter-turn, non-lubricated with resilient encapsulated plug. Valves shall have port areas of not less than 100% of pipe area.

B. Standards, Approvals and Verification:
   1. Valves shall be designed, manufactured and tested in accordance with American Water Works Association Standard ANSI/AWWA C517.
   2. All Plug Valves shall be certified Lead-Free in accordance with NSF/ANSI 372.
   3. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections:
   1. Threaded valves shall have threaded NPT full size inlets. The connection shall be hexagonal for a wrench connection.
   2. Flanged valves shall have flanges with drilling to ANSIB16.1, Class 125.
   3. Mechanical Joint valves shall fully comply with ANSI/AWWA C111/A21.11.

D. Manufacture:
   1. Manufacturer shall demonstrate a minimum of ten (10) years' experience in the manufacture of plug valves. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings and operation and maintenance manuals.
   2. The interior and exterior of the valve shall be coated with an NSF/ANSI 61 approved fusion bonded epoxy. Where specifically indicated in the contract documents interior shall be rubber for abrasive or corrosive fluids and glass for a smooth, non-stick surface.

3. Valve shall be marked with the Serial Number, Manufacturer, Size, Cold Working Pressure (CWP) and the Direct and Reverse Actuator Pressure Ratings on a corrosion resistant nameplate.
4. Acceptable Manufacturers:
   a. Valmatic (Basis of Design)
   b. DeZurik
   c. Or equal

2.2 ECCENTRIC PLUG VALVES (1/2-INCH TO 3-INCHES)

A. Design:
   1. Threaded valve seat shall be a machined seating surface.
   2. 2 ½ in. valves and larger shall have a valve seat that is a welded overlay of 95% pure nickel applied directly to the body on a pre-machined, cast seating surface and machined to a smooth finish.
   3. Threaded valves shall have shaft seals which consist of V-type lip seal in a fixed gland with a resilient O-ring spring.
   4. 2 ½ in. valves and larger shall have shaft seals which consist of V-type packing in a fixed gland with an adjustable follower designed to prevent over compression of the packing and to meet design parameter of the packing manufacturer. Removable POP™ shims shall be provided under the follower flanges to provide for adjustment and prevent over tightening.
   5. Permanently lubricated, radial shaft bearings shall be supplied in the upper and lower bearing journals. Thrust bearings shall be provided in the upper and lower journal areas, except for threaded type which only have upper thrust bearings.
   6. Both the packing and bearings in the upper and lower journals shall be protected by a Grit-Guard™ "drip tight" Buna-N shaft seal located on the valve shaft to minimize the entrance of grit into the bearing journal and shaft seal areas.
   7. The threaded valve body shall have 1/8" NPT upstream and downsteam pressure ports.

B. Materials:
   1. Valve bodies and covers shall be constructed of ASTM A126 Class B cast iron for working pressures up to 175 psig and ASTM A536 Grade 65-45-12 for working pressures up to 250 psig. The words "SEAT END" shall be cast on the exterior of the body seat end.
   2. Threaded valve plugs shall be of one-piece construction and made of ASTM A126 Class B cast iron fully encapsulated with a resilient facing per ASTM D2000-BG and ANSI/AWWA C517 requirements.
   3. 2 ½ in. plugs and larger shall be of one-piece construction and made of ASTM A126 Class B cast iron or ASTM A536 Grade 65-45-12 ductile iron and fully encapsulated with resilient facing per ASTM D2000-BG and ANSI/AWWA C517 requirements.
   4. Threaded valves shall have radial shaft bearings constructed of self-lubricating Type 316 stainless steel. The top thrust bearing shall be Teflon.
   5. 2 ½ in. plug valves and larger shall have radial shaft bearings constructed of self-lubricating Type 316 stainless steel. The top thrust bearing shall be Teflon. The bottom thrust bearing shall be self-lubricating Type 316 stainless steel. Cover bolts shall be corrosion resistant with zinc plating.

C. Actuators:
   1. Threaded valves shall be equipped with a hand lever with a dial indicator and open memory stop.

2. Valves 2 ½ in. and larger shall be equipped with a 2-inch square nut for direct quarter turn operation. The packing gland shall include a friction collar and an open position memory stop. The friction collar shall include a nylon sleeve to provide friction without exerting pressure on the valve packing.
3. All gear actuators shall be designed to withstand, without damage, a rim pull of 200 lb. on the hand wheel and an input torque or 300 ft-lbs. for nuts.
4. Buried service actuators shall be packed with grease and sealed for temporary submergence to 20 feet of water. Exposed worm shafts shall be stainless steel.

2.3 ECCENTRIC PLUG VALVES (3-INCHES TO 54-INCHES)

A. Design:
1. Valves shall have port areas of not less than 100% of pipe area.
2. Valves shall have a valve seat that is a welded overlay of 95% pure nickel applied directly to the body on a pre-machined, cast seating surface and machined to a smooth finish.
3. Valves shall have shaft seals which consist of V-type packing in a fixed gland with an adjustable follower and removable shims under the follower flange to provide for adjustment and prevent over compression.
4. Permanently lubricated, radial shaft bearings shall be supplied in the upper and lower bearing journals to eliminate the need for grease fittings. Thrust bearings shall be provided in the upper and lower journal areas, except for threaded type which only have upper thrust bearings.
5. Both the packing and bearings in the upper and lower journals shall be protected by Buna-N shaft seals located on the valve shaft to minimize the entrance of grit into the bearing journal and shaft seal areas.

B. Materials:
1. Valve bodies and covers shall be constructed of ASTM A126 Class B for working pressures up to 175 psig. The words “SEAT END” shall be cast on the exterior of the body seat end.
2. Plugs shall be of one-piece construction and made of ASTM A536 Grade 65-45-12 ductile iron and fully encapsulated with resilient facing per ASTM D2000-BG and ANSI/AWWA C517 requirements.
3. Plug valves shall have radial shaft bearings constructed of self-lubricating Type 316 stainless steel. The thrust bearings shall be PTFE. Cover bolts shall be corrosion resistant with zinc plating.

C. Actuation:
1. Valves shall be equipped with a 2 inch square nut for direct quarter turn operation with a hand lever. The packing gland shall include a friction collar and an open position memory stop. The friction collar shall include a nylon sleeve to provide friction without exerting pressure on the valve packing.
2. Valves shall include a totally enclosed and sealed worm gear actuator with position indicator (above ground service only) and externally adjustable open and closed stops. The worm segment gear shall be ASTM A536 Grade 65-45-12 ductile iron with a precision bore and keyway for connection to the valve shaft. Bronze radial bearings shall be provided for the segment gear and worm shaft. Alloy steel roller thrust bearings shall be provided for the hardened worm.
3. All gear actuators shall be designed to withstand, without damage, a rim pull of 200 lb. on the hand wheel and an input torque or 300 ft-lbs. for nuts.

4. Buried service actuators shall be packed with grease and sealed for temporary submergence to 20 feet of water. Exposed worm gear shafts shall be stainless steel.

D. Coatings:

1. The interior and exterior of the valve shall be coated with a fusion bonded epoxy.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Plug valves shall be installed in strict accordance with the manufacturer's published recommendations.

B. Eccentric Plug Valves: Unless otherwise directed, the following rules shall be observed for the installation of eccentric plug valves on sewage, sludge, or other liquid systems containing solids, silt, or fine sand:

1. The valves shall be positioned with the stem in the horizontal direction.
2. In horizontal pipelines, the plug shall swing upwards when opening, to permit flushing out of solids.
3. The orientation of the valve shall prevent the valve body from filling up with solids when closed; however, where the pressure differential through the valve exceeds 25 psi, the higher pressure for valves without worm gear, electric, or air operators shall be through the valve to force the plug against the seat.
4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines) and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), shall be equipped with worm gear operators for the full range of sizes.
5. For special applications or when in doubt, consult with the manufacturer prior to installation.

C. Except as otherwise indicated, comply with the following requirements:

1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

D. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

E. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

F. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

G. Locate all valves in locations which will allow easy operation and facilitates maintenance.

H. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 MANUFACTURER’S CUSTOMER SERVICE

A. Manufacturer’s authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION 400562

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400565 - VALVES FOR PUMP CONTROL AND CHECK SERVICE

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve.

B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts list for each type of valve. Include this data, product data, shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.2 QUALITY ASSURANCE

A. Supplier shall have at least ten (10) years’ experience in the manufacture of knife gate valves utilizing elastomer cartridge seats, and shall provide references and a list of installations upon request.

B. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

C. Codes and Standards:
   1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
   2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".

PART 2 - PRODUCTS

2.1 SWING CHECK VALVES (2-1/2 INCHES AND SMALLER)

A. General: Swing check valves for steam, water, oil, or gas in sizes 2-1/2 inches and smaller shall be suitable for a steam pressure of 150 psi and a cold water pressure of 300 psi. Units shall have screwed ends unless otherwise indicated, and screwed caps.

B. Body: The valve body and cap shall be of bronze conforming to ASTM B 763 - Copper Alloy Sand Castings for Valve Application, or ASTM B 584 with threaded ends conforming to ASME B1.20.1 - Pipe Threads, General Purpose (inch).

C. Disc: Valves for steam service shall have bronze or brass discs conforming to ASTM B 16 - Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.

D. Hinge Pin: The hinge pins shall be of bronze or stainless steel.

E. Manufacturers, or Equal

1. Crane Company
2. Milwaukee Valve Company
3. Stockham Valves and Fittings
4. Wm. Powell Company

2.2 PLASTIC BALL CHECK VALVES

A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inches, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. Construction: The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections or flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. Seals shall have Viton O-rings, and valve design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

C. Manufacturers, or Equal

1. ASAHI-AMERICA
2. George Fischer, Inc.
3. NIBCO Inc. (Chemtrol Division)
4. Spears Mfg. Co. (PVC, CPVC, AND PP only)

2.3 PLASTIC SWING OR WYE-CHECK VALVES

A. General: Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8-inches or as available, may be used for horizontal or vertical up-flow conditions.

B. Construction: The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction as best suited for each individual service condition. They shall have flanged ends conforming to ASME B16.5 Class 150, and flanged top access covers and shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inches and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

C. Manufacturers, or Equal

1. Valmatic (Swing Flex)
2. ASAHI-AMERICA
3. George Fischer, Inc.
4. Spears Mfg. Co. (Plastic Swing Check only)

2.4 SWING – FLEX CHECK VALVES

A. Scope

1. This section covers the design, manufacture, and testing of 2 in. through 48 in. Swing-Flex Check Valves suitable for cold working pressures up to 250 psig, in water, wastewater, abrasive, and slurry service.
2. The check valve shall be of the full flow body type, with a domed access cover and only one moving part, the flexible disc.

B. Standards and Approvals

1. The valves shall be designed, manufactured, tested and certified to American Water Works Association Standard ANSI/AWWA C508.
2. The valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components – Health Effects, and certified to be Lead-Free in accordance with NSF/ANSI 372.
3. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections

1. The valves shall have flanges with drilling to ANSI B16.1, Class 125.

D. Design

1. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 in. valve shall be capable of passing a 3 in. solid. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator or oil cushion device without special tools or removing the valve from the line.
2. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.
3. The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and reinforced with alloy steel. The flex portion of the disc contains nylon reinforcement and shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a memory disc return action to provide a cracking pressure of 0.25 psig.
4. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures.

E. Materials

1. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B gray iron for 30 in. (800mm) and larger. Optional body materials include ASTM A-351 Grade CF8M, stainless steel for sizes 3” (80 mm) through 12” (300 mm).
2. The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG. Optional disc material includes Viton, EPDM, Hypalon.

F. Manufacture

1. Manufacturer shall demonstrate a minimum of five (5) years’ experience in the manufacture of resilient, flexible disc check valves with hydraulic cushions.
2. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
3. The exterior and interior of the valve shall be coated with an NSF/ANSI 61 approved fusion bonded epoxy coating.
4. Swing-Flex® Check Valves shall be Series #500 as manufactured by Val-Matic® Valve & Mfg. Corporation, Elmhurst, IL. USA or equal.

2.5 DUAL DISK CHECK VALVES

A. Scope

1. This specification covers the design, manufacture, and testing of 2 in. through 12 in. dual disc check valves suitable for pressures up to 250 psig water service.
2. The check valve shall be of the dual disc, wafer style with torsion spring induced closure.

B. Standards, approvals and verification

1. The valves shall be designed, manufactured and tested in accordance with American Water Works Association standard ANSI/AWWA C518.
2. The valves for use in fire protection systems shall be Underwriters Laboratories listed and Factory Mutual approved in sizes 2 1/2”-12”.
3. The valves shall be certified to be lead-free in accordance with NSF/ANSI 61, Annex G.
4. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections

1. Wafer style valves shall be provided in sizes 2 in through 12 in for installation between ANSI B16.1 Class 125 iron flanges, or between ISO 7005-2 PN10 or PN16 flanges. Grooved end valves shall be provided in 2” through 12” for installation on pipe with cut grooves per ANSI/AWWA C606 for steel IPS pipe.

D. Design

1. The body shall be of one-piece construction incorporating a vulcanized synthetic seal.
2. Seal design shall include a raised sealing bead for positive seating at both high and low pressures. The disc shall fully overlap the synthetic seal, preventing pressure indentations.
3. Opening and closing of the valve shall utilize a lift and pivot action to prevent seal wear and ensure long seal life.
4. Disc stabilization in the full open position shall be provided by the use of a stop pin.
5. The stop and pivot pins shall be stabilized by the use of synthetic spheres to prevent wear due to vibration during operating conditions. The design shall incorporate a raised seat and 1/2” body wall to disc clearance to ensure proper operation after long periods of inactivity and potential corrosion buildup.
6. Cv flow coefficients shall be equal to or greater than specified below and verified by an independent testing laboratory.

Valve Size	Cv	
	Wafer	Grooved
2 in	76	77
2.5 in	161	129
3 in	224	209
4 in	400	358
5 in	648	573
6 in	1060	898
8 in	1890	1740
10 in	3340	3180
12 in	5270	4950

8. Closure shall be assisted with a torsion spring to provide a cracking pressure of 0.25 psig.

E. Materials
1. The valve body shall be constructed of astm a536 grade 65-45-12 ductile iron.
2. The disc shall be constructed of astm b584, alloy c87600 (2”-12”) cast bronze. The pivot pins and stop pins shall be type 316 stainless steel.
3. The torsion spring shall be astm a313 type 316 stainless steel.
4. The seal shall be buna-n per astm d2000-bg.

F. Manufacture
1. The valves shall be hydrostatically tested at 2 times their rated cold working pressure. A seat closure test at 2 times the valve rating shall be conducted to demonstrate zero leakage. Additional tests shall be conducted per awwa, ansi, mss or api standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
2. The exterior of the valve shall be coated with a universal alkyd primer.
3. Check valves shall be series #8800w (wafer style) and series #8800g (grooved end) as manufactured by val-matic® valve & mfg. Corporation, elmhurst, il. Usa or approved equal.

2.6 SUCTION LINE FOOT VALVES

A. Scope
1. This section covers the design, manufacture, and testing of 2 in. through 42 in. Sure Seal Foot Valves suitable for pressures up to 200 psig water service.
2. The Foot Valve shall be of the full flow globe style designed to provide silent operation, positive seating, and full flow area.

B. Standards, Approvals and Verification
1. The valves shall be certified to be Lead-Free in accordance with NSF/ANSI 61, Annex G.
2. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections
1. The Foot Valves shall be provided with flanges in accordance with ANSI B16.1 for Class 125 iron flanges.

D. Design
1. The valve design shall incorporate a center guided disc, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe size.
2. All component parts shall be field replaceable without the need of special tools. A replaceable guide bushing shall be provided and held in position by threaded bushing retainer.
3. The valve disc shall be concave to the flow direction providing for disc stabilization, maximum strength, and a minimum flow velocity to open the valve.
4. The valve disc and seat shall have a seating surface finish of 32 micro-inch or better to ensure positive seating at all pressures. A Buna-N seal shall be provided on the seat to provide for zero leakage at both high and low pressures without overloading or damaging the seal. The seal design shall provide both a metal to metal and a metal to Buna-N seal.
5. A heavy-duty basket type screen shall be bolted to the inlet flange outside diameter and provide 3-4 times the pipe area.

E. Materials

1. The valve body shall be constructed of ASTM A126 Class B cast iron.
2. The seat and plug shall be ASTM A351 Grade CF8M stainless steel.
3. The basket screen shall be stainless steel, Type 304.

F. Manufacture
1. The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure. Additional tests shall be conducted per AWWA, ANSI, MSS or API standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
2. The exterior of the valve shall be coated with a universal alkyd primer.
3. Foot Valves shall be Series #1900 as manufactured by Val-Matic® Valve & Mfg. Corporation, Elmhurst, IL. USA or equal.

2.7 SURGE RELIEF ANGLE VALVES

A. Scope
1. This section covers the design, manufacture and testing of Surge Relief Angle Valves.
2. Surge Relief Angle Valves shall be normally closed against the system pressure by external spring(s) in compression and shall open quickly to relieve pressure when the system pressure exceeds the pressure relief setting. The pressure relief setting shall be factory set and field adjustable by adjusting the spring compression. The valve will begin to close when the system pressure subsides below the pressure relief setting. The closing speed shall be adjustable to suit the application by means of infinitely adjustable, lockable flow control valve.

B. Design
1. Body shall be a 90 degree elbow design conforming to the center-to-face dimension for long-radius elbows per ASME B16.1 and ASME B16.42. Valve shall be a compact design to fit in tight installation spaces.
2. Body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron. Body Seat shall be 316 stainless steel. Flanges shall be flat faced and conform to ASME B16.42 Class 150. Valve shall be proof-of-design tested to 5,000 cycles.
3. A self-contained, sealed hydraulic system shall provide closing speed control. The valve cover shall provide an air gap between the line fluid and the hydraulic oil that will indicate seal wear and prevent contamination of line fluid or hydraulic oil. The valve shall be capable of being mounted in any position without modification or customization of the hydraulic system components. A mechanical stroke counter with manual reset shall provide local indication of total valve cycles.
4. External spring(s) located on the valve cover in a protective steel enclosure shall provide closing force. Springs shall be sized to optimally match customer-specified relief pressure setting to minimize pressure rise above the set-point in order to fully open valve. A single adjustment screw shall be provided for field adjustment of relief pressure setting.
5. Valve Disc shall have a replaceable seat ring of Acrylonitrile-Butadiene (NBR); Terpolymer of Ethylene, Propylene and A Diene (EPDM) or Fluoro Rubber (FKM) for tight shutoff.

C. Manufacturer
1. APCO Model SRA-3000A as manufactured by DeZurik or approved equal.

D. Warranty

1. Valves and actuators shall be warranted by the manufacturer for defects in materials and workmanship for a period of two years (24 months) from date of shipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valve shall be installed in accordance with manufacturer's written Installation and Operation Manual and approved submittals.

B. Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

C. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

D. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

3.4 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION 400565

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400567 – BALL VALVES

PART 1 - GENERAL

1.1 SCOPE:

A. Furnish and install all valves complete and in accordance to the requirements of the Contract Documents.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve.

B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts list for each type of valve. Include this data, product data, shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service.

B. Valve Types: Provide valves of same type by same manufacturer.

C. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

D. Codes and Standards:

1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".
3. U-PVC: Conforming to ASTM D1784 Cell Classification 12454 A
4. CPVC – Conforming to ASTM D1784 Cell Classification 23567 A
5. Polypropylene – Conforming to ASTM D4101 Cell Classification PP0210B67272
6. PVDF – Conforming to ASTM D3222-91A Cell Classification Type II

PART 2 - PRODUCT

2.1 PLASTIC BALL VALVES (1/2” – 6”)

A. All valves shall be true-union design with 2-way blocking capability. PTFE seats shall have elastomeric backing cushions to provide smooth even stem torque and to compensate for wear. Valves shall feature molded ISO mounting top flange for actuation installation and Panel Mount feature on bottom of valve for securing in-line. The handle shall double as the spanner wrench for maintenance and carrier adjustment.

B. Valve shall have a pressure rating of 150 psi at 70ºF.

C. Where noted on contract drawings, a 1/8” Vent Hole factory drilled and de-burred by the manufacturer shall be added to eliminate the hazard of pressurization.

D. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering ball valves which may be incorporated in the work are:

1. Asahi America, Inc.
2. George Fischer
3. Dura Plastic Products, Inc.
4. Hayward
5. Or equal.

2.2 STAINLESS STEEL BALL VALVES

A. Features:
1. 316 SS Ball Construction
2. SS Body construction
3. RPTFE seat
4. Threaded
5. Full Port
6. Two piece body design
7. Solid Ball Construction
8. SS Lever and Nut
9. Blow out proof stern design
10. Nylon lever grip
11. 150 psi rated

B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering ball valves which may be incorporated in the work are:
1. Apollo Valves
2. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Except as otherwise indicated, comply with the following requirements:

Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections.

1. Pipe Size 2" and Smaller: One of the following, at Installer's option:

   a. Threaded valves.
   b. Flanged valves.

2. Pipe Size 2-1/2" and Larger:

   a. Flanged valves.
   b. Grooved joint valves.

D. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

B. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

END OF SECTION 400567

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 400578 – COMBINATION AND SURGE RELIEF VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide combination and surge relief valves and appurtenances, complete and operable, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300.

PART 2 - PRODUCTS

2.1 GENERAL

A. This specification is intended to cover the design, manufacture, and testing of 1 in. through 8 in. combination air and surge relief valves suitable for pressures up to 175 psig.

B. Combination air valves shall be automatic float operated valves designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall open during draining or if a negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure. The valve shall perform the functions of both air release and air/vacuum valves and furnished as a single body or dual body type as indicated on the plans.

2.2 STANDARDS, APPROVALS AND VERIFICATION

A. Valves shall be manufactured and tested in accordance with American Water Works Association (AWWA) Standard C512.

B. Valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components.

C. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

2.3 WASTEWATER COMBINATION VALVES

A. Connections

1. Single body valves sizes 4 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size with a 2 in. inlet on 1 in. valves. The body inlet connections shall be hexagonal for a wrench connection. The body shall have 2” NPT cleanout and 1” NPT drain connection on the side of the casting.
2. Dual body valves sizes 3 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size with a 2 in. inlet on 1 in. valves. The body inlet connection shall be hexagonal for a wrench connection. Valve sizes 4 in. through 6 in. shall have bolted

flanged inlets and NPT outlets. 8 in. valves shall have flanged inlets and outlets. Flanges shall be in accordance with ANSI B16.1 for Class 125 iron flanges.

3. The valve shall have three additional NPT connections for the addition of backwash accessories.

B. Design:

1. Both single and dual body valves shall provide an extended body with a through flow area equal to the nominal size. Floats shall be unconditionally guaranteed against failure including pressure surges. A resilient bumper shall be provided on 4 in. and larger sizes to cushion the float during sudden opening conditions. The seat shall provide drop tight shut off to the full valve pressure rating.
2. Dual body valves shall consist of a wastewater air release valve piped to a wastewater air/vacuum valve with a full-ported brass ball valve.
   a. The wastewater air release valve shall have an extended leverage mechanism with sufficient mechanical advantage so that the valve will open under full operating pressure. An adjustable threaded resilient orifice button shall be used to seal the precision discharge orifice in the cover.
   b. The wastewater air/vacuum valve sizes 4 in. and larger shall have a cover fitted to the valve body by means of a machined register to maintain concentricity between the top and bottom guide bushings at all times. The tandem float assembly shall have a hexagonal guide shaft supported in the body by circular bushings to prevent binding from debris. The upper float shall be protected against direct water impact by an internal baffle. The seat shall be a minimum of 0.5 in. thick on 2 in. and larger valves and secured in such a manner as to prevent distortion.
3. Single body valves shall have a full port orifice, a double guided plug, and an adjustable threaded orifice button. The 1 in. body shall be globe style to increase float clearance and reduce clogging. The plug shall be protected against direct water impact by an internal baffle and an extended float stem. The plug shall have a precision orifice drilled through the center stem. The float shall include a sensitivity skirt to minimize spillage.

C. Materials:

1. The valve body and cover shall be constructed of ASTM A126 Class B cast iron.
2. The float, plug, guide shafts, and bushings shall be constructed of type 316 stainless steel. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N.

2.4 SURGE RELIEF AIR VALVES

A. Scope

1. This specification is intended to cover the design, manufacture, and testing of 1/2 in. (15 mm) through 20 in. (500 mm) Surge Suppression Air Valves suitable for pressures up to 740 psig (5100 kPa) clean water or raw water service.
2. Surge Suppression Air Valves shall be automatic float operated valves designed to control the exhaust of air during the filling of a piping system and close upon liquid entry. The valve shall fully open during draining or if a negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure. The valve is equipped with a regulated exhaust device and performs the functions of both Air Release and Air/Vacuum Valves and furnished as a single body or dual body type as indicated on the plans.
3. Provide valves

B. Standards, Approvals and Verification

1. Valves shall be manufactured and tested in accordance with American Water Works Association (AWWA) Standard C512.
2. Valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components - Health Effects.
3. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections
1. Dual body valve sizes 3 in. (75 mm) and smaller and single body valve sizes 4 in. (100 mm) and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection.
2. Larger sizes shall have bolted flanged inlets and threaded or flanged outlets. Inlet flanges shall be in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.5 for Class 300 steel flanges.
3. The valve shall have two additional NPT connections for the connection to gauges, testing, and draining.

D. Design
1. Both single and dual body valves shall provide a through flow area equal to the nominal size. Floats shall be unconditionally guaranteed against failure including pressure surges. The cover shall be bolted to the body and sealed with a flat gasket. A resilient bumper shall be provided on 4 in. (100 mm) and larger sizes to cushion the float during sudden opening conditions. The resilient seat shall be replaceable and provide drop tight shut off to the full valve pressure ratings.
2. Dual body combination valves shall consist of an Air Release Valve piped to an Air/Vacuum Valve with a quarter-turn, full-ported bronze ball valve on 4 in. and larger sizes.
3. The Air Release Valve shall have a leverage mechanism with sufficient mechanical advantage so that the valve will open under full operating pressure. Simple lever designs shall consist of a single pivot arm and a resilient orifice button. Compound lever designs shall consist of two levers and an adjustable threaded resilient orifice button.
4. The Air/Vacuum Valve sizes 4 in. (100 mm) and larger shall have a cover fitted to the valve body by means of a machined register to maintain concentricity between the top and bottom guide bushings at all times. The float shall be double guided with a guide shaft extending through the float to prevent any contact with the body. The float shall be protected against direct water impact by an internal baffle bolted to the cover or integrally cast in the body. The seat shall be a minimum of .5 in. (12 mm) thick on 2 in. (50 mm) and larger valves and secured in such a manner as to prevent distortion. Valves with working pressures above 500 psig (3450 kPa) shall have metal seats with synthetic seals.
5. Single body combination valves shall have an expanded outlet to provide full flow area around the guide mechanism. The valve shall have a double guided plug on 2 in. (50 mm) and larger sizes, and an adjustable threaded orifice button. The plug shall be protected against direct water impact by an internal baffle. On valve sizes 4 in. (100mm) and smaller, the plug shall have a precision orifice drilled through the center stem. On valve sizes 6 in. (150 mm) and larger, air release and air/vacuum mechanisms shall be provided as separate units contained within the same body and meet the same design specifications for the Dual Body Combination Valve in section C.2 above.
6. A Regulated Exhaust Device shall be provided to reduce pressure surges due to column separation or rapid changes in velocity and pressure in the pipeline.

7. The Regulated Exhaust Device shall be mounted on the inlet of the Combination Air Valve, allow free air flow in and out of the valve, close upon rapid air exhaust, and control the air exhaust rate to reduce pressure surges.
8. The device shall have a flanged globe-style body with a center guided disc and seat assembly. The disc shall have threaded holes to provide adjustment of the air exhaust rate through the valve. The holes shall provide for a flow area of 5% of the nominal valve size.

E. Materials
1. The valve body and cover shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves. Class 300 ductile iron valves shall be constructed of ASTM A536 Grade 65-45-12 ductile iron. Dual Body Class 300 steel valves shall be constructed of ASTM A216 Grade WCB cast steel.
2. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Non-metallic floats, linkage, or bushings are not acceptable. Resilient seats shall be Buna-N. Class 300 steel dual body valves shall have a 316 stainless steel seat with Buna-N seal to provide an initial contact to Buna-N with a final metal-to-metal contact to prevent over compression of the resilient seal.
3. The Regulated Exhaust Device body shall be ASTM A536 Grade 65-45-12 ductile iron up to 12" and ASTM A126 Class B for 14" and larger. The seat and disc shall be bronze.

F. Coating
1. Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550 when specified.

G. Manufacturer
1. The manufacturer shall demonstrate a minimum of five (5) years experience in the manufacture of air valves. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
2. Surge Suppression Air Valves shall be Series 201CSSA (single body) or Series 100SSA/38 (Dual Body) as manufactured by Val-Matic Valve and Manufacturing Corporation, Elmhurst, Il, USA or approved equal.

2.5 SURGE RELIEF ANGLE VALVES

A. Scope
1. This specification is intended to cover the design, manufacture, and testing of Surge Relief Angle Valves suitable with pressures relief ratings up to 200 psig (1380 kPa) clean water or raw water service. The valves shall be designed and manufacture for an installation with a maximum 175 psig system ppressure.

B. Manufacturer
1. All valves shall be APCO model SRA-3000A Surge Relief Angle Valves as manufactured by DeZURIK or approved equal.

C. Design
1. Surge Relief Angle Valves shall be normally closed against the system pressure by external spring(s) in compression and shall open quickly to relieve pressure when the system pressure exceeds the pressure relief setting. The pressure relief setting shall be factory set and field adjustable by adjusting the spring compression. The valve will begin to close when the system pressure subsides below the pressure relief setting.

2. The closing speed shall be adjustable to suit the application by means of infinitely adjustable, lockable flow control valve.
3. Body shall be a 90 degree elbow design conforming to the center-to-face dimension for long-radius elbows per ASME B16.1 and ASME B16.42. Valve shall be a compact design to fit in tight installation spaces.
4. Body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron. Body Seat shall be 316 stainless steel. Flanges shall be flat faced and conform to ASME B16.42 Class 150. Valve shall be proof-of-design tested to 5,000 cycles.
5. A self-contained, sealed hydraulic system shall provide closing speed control. The valve cover shall provide an air gap between the line fluid and the hydraulic oil that will indicate seal wear and prevent contamination of line fluid or hydraulic oil. The valve shall be capable of being mounted in any position without modification or customization of the hydraulic system components. A mechanical stroke counter with manual reset shall provide local indication of total valve cycles.
6. External spring(s) located on the valve cover in a protective steel enclosure shall provide closing force. Springs shall be sized to optimally match customer-specified relief pressure setting to minimize pressure rise above the set-point in order to fully open valve. A single adjustment screw shall be provided for field adjustment of relief pressure setting.
7. Valve Disc shall have a replaceable seat ring of Acrylonitrile-Butadiene (NBR) for tight shutoff.

D. Warranty
1. Warranty Valves and actuators shall be warranted by the manufacturer for defects in materials and workmanship for a period of two years (24 months) from date of shipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Except as otherwise indicated, comply with the following requirements:
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

D. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

E. Locate all valves in locations which will allow easy operation and facilitates maintenance.

F. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

3.4 WARRANTY

A. Unless noted otherwise, a minimum 12-month warranty from date of installation or 18 months from shipment shall be provided for parts and workmanship.

END OF SECTION 400578

SECTION 40 61 13 – PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. General requirements which apply to all Instrumentation and Control for Process Systems (hereafter referred to as I&C).

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents to provide a complete and coordinated project.

C. Complete I&C System

1. The requirements for the I&C System shall be the responsibility of a single company hereafter referred to as the Instrumentation Supplier (IS). The IS shall be responsible for all parts of this Section and Sub-Sections as well as all other related sections that may pertain to the I&C System.
2. The Contractor, through the IS and qualified electrical and mechanical installers, shall be responsible to the Owner for the implementation of a complete I&C System. The IS shall provide all necessary coordination, material, and labor such that the entire system be complete and functional. This includes but is not limited to the proper operation and monitoring of electrical power systems, process systems, mechanical equipment, instrumentation, control panels, programmable controllers, communications/networking, and SCADA system.
3. The overall I&C system design is based upon non-certified information that has been furnished by various equipment manufacturers and vendors. It is the Contractor's responsibility to include in the bid and installation all labor and material to provide a complete system based upon actual information from equipment being supplied for the project. Any changes or additions due to non-certified manufacturer or vendor information shall be provided at no additional cost to the Owner.

1.2 REFERENCES

A. The installation and commissioning of the I&C System shall conform to all applicable codes, regulations, standards, and specifications, including, but not limited to those listed below. These publications are referenced to by designation but not by edition. The latest edition accepted by the Authority Having Jurisdiction in effect at the time of bid shall govern.

1. State and Local Codes and Authority Having Jurisdiction (AHJ)
2. American National Standards Institute (ANSI)
3. American Petroleum Institute (API)

4. Federal Communications Commission (FCC)
5. Federal Occupational Safety and Health Act (OSHA)
6. International Society of Automation (ISA)
7. Institute of Electrical and Electronic Engineers (IEEE)
8. National Electric Code (NEC).
9. National Electrical Manufacturers Association (NEMA)
10. National Fire Protection Association (NFPA)
11. Underwriters Laboratories, Inc. (UL)

1.3 DEFINITIONS

A. The following definitions may be used throughout this section and subsections (refer to the contract drawings sheet GI-1 for instrumentation abbreviations):

1. CTC: Communications termination cabinet.
2. FAT: Factory acceptance test.
3. HMI: Human machine interface.
4. I&C: Instrumentation and control for process systems
5. IS: Instrumentation supplier.
6. LAN: Local area network.
7. LCP: Local control panel.
8. NC: Normally closed.
9. NO: Normally open.
10. OIT: Operator interface terminal.
11. OSI: Owner’s System Integrator.
12. PC: Personal computer.
13. PID: Control action, proportional plus integral plus derivative.
14. PLC: Programmable logic controller.
15. P&ID: Process and instrumentation diagram
16. RIO: Remote input/output
17. SCADA: Supervisory control and data acquisition.
18. SI: System Integrator.
19. UPS: Uninterruptible power supply.
20. VCP: Vendor control panel.
21. WAN: Wide area network

1.4 I&C SYSTEM REQUIREMENTS

A. Work provided outside of Contractor’s scope:
   1. The following equipment is being furnished by the Owner:
      a. SCADA Equipment

B. The Work is to provide a complete and operational I&C System as described by the Contract Documents. This includes but is not limited to the following:

   1. Before providing a bid as the IS, coordinate with all bidders such that all costs associated with a complete I&C System are accounted for. The Owner shall not be responsible for any additional costs for scope items that have been excluded from the bid because of not coordinating with all bidders.

2. The IS shall submit a statement of qualifications verifying that it meets the requirements of 406113.1.8. The IS must be approved by the Engineer before proceeding with the Work.

3. In order to provide a complete system, oversee and coordinate with all equipment and services being provided outside of Contractor's scope.
   a. The Engineer is responsible to ensure that equipment being supplied by others related to the I&C System complies with the requirements of the Contract Documents
   b. The Contractor and IS are responsible to coordinate the installation, commissioning and scheduling of equipment related to the I&C System that are provided by others.

4. Oversee and coordinate with all equipment and services being provided by the Contractor but outside of the IS's scope.
   a. Inform all vendors and suppliers providing equipment related to the I&C System the requirements of Division 40.
   b. The Owner is not responsible for any additional costs incurred by requiring vendors and/or subcontractors to meet the requirements of Division 40.
   c. If a vendor or supplier is unable to meet the requirements of Division 40, the Contractor may submit in writing to the Engineer the reasons for non-compliance. The Engineer will then evaluate the reasons and determine whether a solution may be determined or if a different vendor or supplier is required.
   d. The Contractor and IS are responsible for coordinating with vendors and suppliers the FAT, installation, commissioning, calibration, and scheduling for the associated I&C equipment.
   e. The IS is responsible to ensure that panel and loop drawings be supplied for vendor and subcontractor equipment. If the vendors and/or subcontractors are preparing the panel and/or loop drawings, they shall comply with the requirements of Division 40 and shall match those provided by the IS.

5. The IS shall conduct a Pre-Submittal Conference before producing any submittals. The conference should include all parties involved with the I&C System including the Engineer and Owner. The purpose of the conference shall be to review the project, make sure all parties understand their roles and responsibilities and to go over submittal requirements.

6. Prepare I&C System Submittals which includes the following:
   a. Instrumentation hardware submittal (including TR20 forms).
   b. Recommended spare parts submittal.

7. Following submittal approvals, do the following:
   a. Procure all instrumentation hardware and accessories.
   b. Procure hardware for and fabricate all control panels being provided.
   c. Perform FAT's for all control panels being provided.

8. Programming and integration shall be supplied by the OSI. Oversee and coordinate the programming and integration with the OSI for a complete I&C System.

9. Oversee the installation of the I&C System.

10. Perform bench and field calibrations of instruments as required.

11. Oversee and document loop testing.

12. Oversee and document commissioning.

13. Maintain record drawings.
    a. Maintain on the construction site a set of the Instrumentation Drawings that shall be continuously marked up during construction.
    b. The drawings should be updated at least weekly and will be checked monthly by the Owner's representative.
    c. Upon completion of startup, submit the marked-up drawings to the Engineer for review and for drafting.

14. Prepare O&M manuals.
    a. Provide O&M manuals in accordance with Section 017823.
    b. Prepare an O&M manual for each major process area or building. Each of these manuals shall be divided into the following categories:
        1) Table of Contents/Index.
        2) Process & Instrumentation Diagrams
        3) Control Panel Record Drawings, Bill of Materials and Design Data.
        4) Record Loop Drawings
    c. Prepare O&M manuals that cover comprehensive information for the I&C System. These manuals shall include the following:
        1) Table of Contents/Index.
        2) Finalized Instrument Summary
        3) Finalized TR20 Instrument Forms
        4) Instrumentation Installation Details
        5) Instrument Operational Manuals
        6) Recommended Spare Parts List

15. Provide training.

1.5 ACTION SUBMITTALS

A. General
1. Submittals for Division 40 shall meet the requirements of Section 013300 Contractor Submittals. In addition, the following requirements shall be met:
    a. Submittals shall include bills of materials with quantities, makes, models, exact part numbers and descriptions.
    b. Edit all submittals such that only pertinent information is submitted. Neatly cross out information that does not apply, options that are not being supplied, etc.
    c. Show product dimensions, construction, and installation details, wiring diagrams, and specifications.
    d. If there are exceptions to the Contract Drawings and Specifications, provide a list of exceptions with detailed explanations for the exceptions. The Engineer will review the list of exceptions and determine whether a solution may be determined or if the exception(s) will not be allowed.
2. Furnish submittal required by each Section within Division 40.
3. When submitting on equipment, use the equipment and instrumentation tags depicted in the Contract Drawings.

B. Instrumentation hardware submittal
   1. Provide a comprehensive submittal that includes all instrumentation being supplied by the IS. Divide the submittal into the following:
      a. Table of Contents/Index.
      b. Instrument summary.
      c. Instrument TR20 Forms.
      d. Instrument Cut Sheets.
      e. Instrument Installation Drawings.
   2. Provide an instrument summary (sorted by tag number) that has the following information:
      a. Tag number.
      b. Make, model and description.
      c. Associated process.
      d. Location.
      e. Calibrated range.
      f. Referenced loop drawing number and P&ID.
      g. Associated PLC.
   3. Furnish TR20 instrumentation forms for each instrument using the forms outlined in ISA-TR20.00.01-2007. This requirement includes all instruments that are being installed as part of the project, whether they are Contractor, Owner and/or Vendor supplied. Show on each sheet who is the responsible party for supplying the instrument. The TR20 sheets should be provided electronically in Microsoft Word or Excel as well.
   4. Provide instrument cut sheets for each instrument make and model being supplied for the project. Each cut sheet should have a list of instrument tag numbers that pertain to that cut sheet. The cut sheets should have enough information to verify that the instrument conforms to the Contract Drawings and Specifications.
   5. Instrument installation drawings
      a. Provide instrument installation drawings for each make and model of instrument being supplied.
      b. Delineate what is being supplied by the IS and what is being supplied by other installers.
      c. Show overall dimensions, mounting locations and elevations.
      d. Show all cabling, conduit and piping locations.
      e. Show the ambient conditions of the location where the instrument is being installed which includes ambient temperature and humidity extremes, whether the atmosphere is corrosive and the area classification.
      f. Show mounting requirements, brackets, stands and anchoring.
      g. Show means for sun protection where required.

C. Recommended Spare Parts Submittal
   1. Submit a list of spare parts for all the equipment associated with the I&C System. The list of spare parts shall include list pricing for each item.
   2. Provide the name, address and phone number for each manufacturer and manufacturer's local sales representative.
   3. Indicate whether the spare parts are being provided under this contract or not.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Calibration certificates.

C. As-built TR20 forms.

1.7 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.8 QUALITY ASSURANCE

A. All equipment supplied for this project shall meet the requirements of the National Electric Code (NEC) and shall be listed by and bearing the label of the Underwriters' Laboratories (UL).

B. The IS shall be a company that has been actively involved in the installation and commissioning of I&C Systems for a minimum period of five years.

C. The IS shall have adequate facilities, manpower and technical expertise to perform the Work associated with the I&C System and as outlined by the Contract Documents.

D. The IS shall have similar project experience of at least four successfully completed projects for a similar wastewater system. The IS company must have performed similar work for these projects as required herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials provided under this Contract shall be new and free from defects.

2.2 MANUFACTURERS

A. All equipment provided for the I&C System shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. Instruments which utilize a common measurement principle (for example, float switches) shall be furnished by a single manufacturer. Panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer.

2.3 OPERATING CONDITIONS

A. The I&C System shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:
   1. Environment: Wastewater Treatment Plant.
   2. Temperature Extremes: -4°F to 104°F (Outdoors); 40°F to 104°F (Indoors).
   3. Relative Humidity: 20% to 90%, non-condensing.

B. Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided to maintain instrumentation devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide power wiring for these devices. Enclosures suitable for the environment shall be furnished. Instrumentation in hazardous areas shall be suitable for use in the hazardous or classified location in which it is to be installed.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. After completion of shop assembly, factory test, and approval, equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.

B. Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package.

D. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 MANUFACTURER’S SERVICES

A. Manufacturer’s services shall be furnished for the following equipment:
   1. Vendor supplied equipment that contain programmable controllers, operator interfaces and/or instrumentation that requires site calibration.

B. The Contractor shall furnish the following manufacturer's services for the instrumentation listed below:
   1. Perform bench calibration.
   2. Oversee installation.
   3. Verify installation of installed instruments.
   4. Certify installation and reconfirm manufacturer's accuracy statement.

5. Oversee loop testing and pre-commissioning
6. Train the Owner's personnel.

3.3 INSTALLATION

A. Instrumentation shall be installed per the Instrument Installation Drawings that have been submitted and approved and per the requirements of Division 40. This includes all instrumentation for the I&C System, regardless of who the supplier is. Instrumentation shall be mounted so that it is easily accessible and viewable and such that it does not restrict access to other equipment. Mount instrumentation to pipe stands or wall mounts if they are not directly mounted or if the Contract Drawings indicate otherwise.

B. The I&C System indicated throughout the design are diagrammatic and therefore locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Contractor shall make such changes without additional cost to the Owner.

C. The I&C System is integrally connected to electrical, mechanical, and structural systems. Coordinate with these other disciplines the installation of these related components. All conduit, cables and field wiring shall be as required by Division 26.

D. Instruments, control panels and all other I&C System related equipment shall be anchored by methods that comply with seismic requirements applicable to the Site.

E. Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned, and recalibrated by an authorized service facility of the instrument manufacturer. The Contractor shall provide certification of this Work prior to reinstallation of each instrument.

F. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that Work. Such changes shall not be a basis of claims for extra Work or delay.

G. Instrumentation, control panels, wiring and all other I&C equipment shall be properly tagged and/or labeled per the requirements of Section 260553.

H. Installation of the I&C System shall be according to the finalized Loop Drawings

3.4 FACTORY ACCEPTANCE TESTING (FAT)

A. The IS shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the Engineer and Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the Engineer prior to testing. No shipments shall be made without the Engineer's approval.

B. For each FAT, the IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. The FAT Plan and Procedure shall as a minimum shall have the following:
   1. Descriptions of test methods to be performed during the FAT.
   2. FAT Schedule and Procedure
   3. FAT Checklists that allow for sign-off and comments for each test method and procedure.

C. Control Panel Completion Test Methods: The following test methods should be performed during the FAT for each control panel:
   1. Completed Shop Drawings: Demonstrate that the control panel has been built according to the shop drawings and that the shop drawings are accurate.
   2. Panel Layout: Demonstrate that the control panel has been laid out as designed and as required by Division 40.
   3. Power Distribution: Demonstrate all power distribution circuits, including but not limited to AC power circuits, UPS operation, signals and circuits and DC circuits.
   4. Control Circuits: Demonstrate the correct installation of each control circuit. Using a signal generator or multi-meter, show the correct operation of each input, output, relay, barrier, buttons, switches, or any other control device. Demonstrate the proper functionality of any hard-wired interlocks that may be associated with each control circuit.
   5. Panel Networking/Communications: If any form of communications is associated with the control panel, verify the proper operation of each communication port and link.

D. Control Loop Test Methods: To demonstrate that the control panel will provide its function as intended, provide the following control loop test methods. If programming for the control panel is provided by others, coordinate with the programmer to have all programming completed and tested prior to the FAT. If needed, coordinate to have the programmer present for the FAT.
   1. Alarm Functions: Verify and/or simulate each alarm condition associated with each control loop.
   2. Local Manual and Auto Functions: Verify and/or simulate each Local Manual and/or Auto function associated with each control loop.
   3. SCADA Manual and Auto Functions: Verify and/or simulate each SCADA Manual and/or Auto function associated with each control loop.
   4. Control Loop Interlocks: Demonstrate the functionality of any software interlocks that may be associated with each control loop.

E. If the FAT does not pass and needs to be repeated, the IS shall be responsible for additional per diem costs incurred by the Engineer and Owner.

F. All changes and/or corrections made during the FAT shall be noted on the checklists.

G. Following completion and approval of all FAT, provide the finalized checklists to the Engineer and as part of the equipment shop drawings.

3.5 FIELD QUALITY CONTROL

A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

3.6 CALIBRATION

A. Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.

C. Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations need adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

D. Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.

F. For each instrument calibration, provide a calibration sheet and update the corresponding TR20 Instrument Form with the new calibration data. The Calibration sheet shall include the following as a minimum:
1. Date of calibration
2. Project Name.
3. Tag Number.
4. Manufacturer, model and serial number.
5. Calibration data including range, input, output and measurement at each calibration point.
6. Space for comments.
7. Space for sign-off by party performing calibration.

G. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The IS shall sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.7 LOOP TESTING

A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
1. All associated equipment, conduit and wire has been permanently installed, terminated, and inspected.
2. All wiring has been properly pulled, terminated, and labeled.

3. Each wire has been tested with a point-to-point test.
4. All control panels and electrical equipment have been checked out and tested as required by Division 26.
5. All instrumentation has been appropriately installed and calibrated.
6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.

B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
1. Loop Number and Description
2. Check-Off List with room for sign-off and dated by the IS, Programmer, and Owner's Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
    a. Each power distribution circuit.
    b. Each control circuit.
    c. Each alarm circuit.
    d. Each PLC input/output point.
    e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
    f. Each hard-wired and software interlock.

C. Upon completion of the above pre-requisites for loop testing, the IS shall oversee and coordinate each loop test. The IS is responsible to be present for all loop testing, whether the equipment was supplied by the IS or not. The IS is responsible to have all responsible parties associated with each loop present. This includes but is not limited to manufacturer representatives, vendor technicians, electrical installers, mechanical installers, and programmer. The IS shall coordinate with the Owner and Engineer to allow for witnessing of loop testing as deemed necessary by the Owner and Engineer.

D. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays. Any costs associated with re-testing and requiring all parties to return to the site shall in no way be incurred to the Owner.

E. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.

F. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

3.8 COMMISSIONING

A. The IS shall oversee, coordinate and be present during all commissioning activities. The IS shall be responsible for obtaining the assistance of the Contractor and Subcontractors as may be required for commissioning activities.

B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

C. Commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system commissioning and test requirements have been satisfied.

D. Where feasible, system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software-based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

E. Electronic control stations incorporating proportional, integral, or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

3.9 TRAINING

A. Develop a Training Plan for the training requirements of Division 40 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of each training session. Schedule the trainings for after the equipment has been pre-commissioned.

B. As part of the Training Plan, submit a résumé for everyone to be providing training. Training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

C. Each training session shall include a written agenda.

D. The Contractor shall train the Owner’s personnel on the maintenance, calibration and repair of instruments provided.

E. Within 10 days after the completion of each session, the Contractor shall submit the following:

1. A list of Owner personnel who attended the training.
2. A copy of the training materials used during the session with notes, diagrams, and comments.

END OF SECTION 40 61 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 61 21 – PROCESS CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes in-factory and field-testing requirements.

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents to provide a complete and coordinated project.

C. Complete I&C System

1. The requirements for the I&C System shall be the responsibility of a single company hereafter referred to as the Instrumentation Supplier (IS). The IS shall be responsible for all parts of this Section and Sub-Sections as well as all other related sections that may pertain to the I&C System.
2. The Contractor, through the IS and qualified electrical and mechanical installers, shall be responsible to the Owner for the implementation of a complete I&C System. The IS shall provide all necessary coordination, material, and labor such that the entire system be complete and functional. This includes but is not limited to the proper operation and monitoring of electrical power systems, process systems, mechanical equipment, instrumentation, control panels, programmable controllers, communications/networking, and SCADA system.
3. The overall I&C system design is based upon non-certified information that has been furnished by various equipment manufacturers and vendors. It is the Contractor's responsibility to include in the bid and installation all labor and material to provide a complete system based upon actual information from equipment being supplied for the project. Any changes or additions due to non-certified manufacturer or vendor information shall be provided at no additional cost to the Owner.

1.2 SUBMITTALS

A. In addition to the submittal requirements of Section 40 61 13, provide the following:

1. Test Results:
   a. Pass/fail status of all digital I/O.
   b. Results of analog I/O testing.
2. Miscellaneous:
   a. Detailed step-by-step in-factory and field test procedure at least 6 weeks in advance of scheduled test date. Include sign-off sheets and punch list forms and description of configurations to be tested.

b. Complete inventory of equipment to be tested at factory including make, model, and serial number. Label each piece of equipment.
c. Preventative maintenance schedule.
3. Submit in accordance with 01 33 00.

PART 2 - SERVICES

2.1 MANUFACTURER'S SERVICES

A. Manufacturer's services shall be furnished for the following equipment:
1. Vendor supplied equipment that contain programmable controllers, operator interfaces and/or instrumentation that requires site calibration.
   a. Combustible Gas Analyzers
   b. Magnetic Flow Meters
   c. Radar Level Transmitters

B. The Contractor shall furnish the following manufacturer's services for the instrumentation listed below:
1. Perform bench calibration.
2. Oversee installation.
3. Verify installation of installed instruments.
4. Certify installation and reconfirm manufacturer's accuracy statement.
5. Oversee loop testing and pre-commissioning
6. Train the Owner's personnel.

2.2 FACTORY ACCEPTANCE TESTING (FAT)

A. The IS shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the Engineer and Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the Engineer prior to testing. No shipments shall be made without the Engineer's approval.

B. For each FAT, the IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. The FAT Plan and Procedure shall as a minimum shall have the following:
1. Descriptions of test methods to be performed during the FAT.
2. FAT Schedule and Procedure
3. FAT Checklists that allow for sign-off and comments for each test method and procedure.

C. Control Panel Completion Test Methods: The following test methods should be performed during the FAT for each control panel:
1. Completed Shop Drawings: Demonstrate that the control panel has been built according to the shop drawings and that the shop drawings are accurate.
2. Panel Layout: Demonstrate that the control panel has been laid out as designed and as required by Division 40.

3. Power Distribution: Demonstrate all power distribution circuits, including but not limited to AC power circuits, UPS operation, signals and circuits and DC circuits.
4. Control Circuits: Demonstrate the correct installation of each control circuit. Using a signal generator or multi-meter, show the correct operation of each input, output, relay, barrier, buttons, switches, or any other control device. Demonstrate the proper functionality of any hard-wired interlocks that may be associated with each control circuit.
5. Panel Networking/Communications: If any form of communications is associated with the control panel, verify the proper operation of each communication port and link.

D. Control Loop Test Methods: To demonstrate that the control panel will provide its function as intended, provide the following control loop test methods. If programming for the control panel is provided by others, coordinate with the programmer to have all programming completed and tested prior to the FAT. If needed, coordinate to have the programmer present for the FAT.
1. Alarm Functions: Verify and/or simulate each alarm condition associated with each control loop.
2. Local Manual and Auto Functions: Verify and/or simulate each Local Manual and/or Auto function associated with each control loop.
3. SCADA Manual and Auto Functions: Verify and/or simulate each SCADA Manual and/or Auto function associated with each control loop.
4. Control Loop Interlocks: Demonstrate the functionality of any software interlocks that may be associated with each control loop.

E. If the FAT does not pass and needs to be repeated, the IS shall be responsible for additional per diem costs incurred by the Engineer and Owner.

F. All changes and/or corrections made during the FAT shall be noted on the checklists.

G. Following completion and approval of all FAT, provide the finalized checklists to the Engineer and as part of the equipment shop drawings.

2.3 FIELD QUALITY CONTROL

A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

2.4 CALIBRATION

A. Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.

C. Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations need adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

D. Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.

F. For each instrument calibration, provide a calibration sheet and update the corresponding TR20 Instrument Form with the new calibration data. The Calibration sheet shall include the following as a minimum:
   1. Date of calibration
   2. Project Name.
   3. Tag Number.
   4. Manufacturer, model, and serial number.
   5. Calibration data including range, input, output, and measurement at each calibration point.
   6. Space for comments.
   7. Space for sign-off by party performing calibration.

G. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The IS shall sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

2.5 LOOP TESTING

A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
   1. All associated equipment, conduit and wire has been permanently installed, terminated and inspected.
   2. All wiring has been properly pulled, terminated and labeled.
   3. Each wire has been tested with a point-to-point test.
   4. All control panels and electrical equipment have been checked out and tested as required by Division 26.
   5. All instrumentation has been appropriately installed and calibrated.
   6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.

B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
   1. Loop Number and Description
   2. Check-Off List with room for sign-off and dated by the IS, Programmer, and Owner’s Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
      a. Each power distribution circuit.
      b. Each control circuit.
      c. Each alarm circuit.

d. Each PLC input/output point.
e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
f. Each hard-wired and software interlock.

C. Upon completion of the above pre-requisites for loop testing, the IS shall oversee and coordinate each loop test. The IS is responsible to be present for all loop testing, whether the equipment was supplied by the IS or not. The IS is responsible to have all responsible parties associated with each loop present. This includes but is not limited to manufacturer representatives, vendor technicians, electrical installers, mechanical installers, and programmer. The IS shall coordinate with the Owner and Engineer to allow for witnessing of loop testing as deemed necessary by the Owner and Engineer.

D. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays. Any costs associated with re-testing and requiring all parties to return to the site shall in no way be incurred to the Owner.

E. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.

F. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

2.6 COMMISSIONING

A. The IS shall oversee, coordinate and be present during all commissioning activities. The IS shall be responsible for obtaining the assistance of the Contractor and Subcontractors as may be required for commissioning activities.

B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

C. Commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system commissioning and test requirements have been satisfied.

D. Where feasible, system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software-based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

E. Electronic control stations incorporating proportional, integral, or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

END OF SECTION 40 61 21

SECTION 40 61 26 – PROCESS CONTROL SYSTEMS TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes Training requirements.

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents in order to provide a complete and coordinated project.

1.2 DEFINITIONS

A. The following definitions may be used throughout this section and subsections (refer to the contract drawings sheet GI-1 for instrumentation abbreviations):

1. CTC: Communications termination cabinet.
2. FAT: Factory acceptance test.
3. HMI: Human machine interface.
4. I&C: Instrumentation and control for process systems
5. IS: Instrumentation supplier.
6. LAN: Local area network.
7. LCP: Local control panel.
8. NC: Normally closed.
9. NO: Normally open.
10. OIT: Operator interface terminal.
11. PC: Personal computer.
12. PID: Control action, proportional plus integral plus derivative.
13. PLC: Programmable logic controller.
14. P&ID: Process and instrumentation diagram
15. RIO: Remote input/output
16. SCADA: Supervisory control and data acquisition.
17. SI: System Integrator.
18. UPS: Uninterruptible power supply.
19. VCP: Vendor control panel.
20. WAN: Wide area network

1.3 SUBMITTALS

A. TRAINING

1. Develop a Training Plan for the training requirements of Division 40 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of

each training session. Schedule the trainings for after the equipment has been pre-commissioned.

2. As part of the Training Plan, submit a résumé for everyone to be providing training. Training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.
3. Each training session shall include a written agenda.
4. The Contractor shall train the Owner’s personnel on the maintenance, calibration and repair of instruments provided.
5. Within 10 days after the completion of each session, the Contractor shall submit the following:
6. A list of Owner personnel who attended the training.
7. A copy of the training materials used during the session with notes, diagrams and comments.

PART 2 - EXECUTION

2.1 MAINTENANCE TRAINING

A. Cover following areas as a minimum:

1. Testing programs which can isolate faults to functional area.
2. Theory, logic flow, physical hardware awareness, and interface connections and assembly of each equipment item.
3. Diagnostic procedures using special and general-purpose test equipment. Theory, testing, and troubleshooting procedures given for special test equipment.
4. Operation of computers and peripherals.
5. Programming routines and procedures to enable students to take advantage of on-line and standby equipment for maintenance and performance verification.
6. Present short operator's course to ensure students understand operator functions and man/machine interfaces. Explain displays and printouts so students understand how information is derived, when it is presented incorrectly, and use of guidelines to differentiate between software and hardware problems.

2.2 INSTRUMENT TRAINING

A. Cover following areas as a minimum:

1. General principle of operation.
2. Calibration schedule.
3. Calibration procedure.
4. Calibration equipment required (if needed).
5. Recommended spare parts.
6. Consumable part – recommended replacement schedule (e.g. Reagents, filters, probe tips) and procedure.
7. General care and maintenance with special consideration to all instruments that may require cleaning such as pressure and level elements, etc.

2.3 HMI TRAINING

A. HMI functionality.

B. How key components work; shall include, but not be limited to:
   1. Entering of set points.
   2. Using alarm matrix.
   3. Acknowledging and clearing alarms.

END OF SECTION 40 61 26

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 71 13 – MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Magnetic flow meters are used to provide continuous flow measurement of the process. The flow instrument consists of a transmitter and a flow element.

1.2 ACTION SUBMITTALS

A. Product Data:
1. Dimensional Drawings
2. Materials of Construction
3. Measurement Accuracy
4. Range and range ability
5. Enclosure Rating
6. Classification Rating

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each process measurement system shall typically consist of a sensor and a transmitter. Where shown on the drawings, the transmitter may be utilized for multiple sensors. When a transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.

B. Each transmitter shall be equipped with means to transmit process measurement information to the plant SCADA system.

1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
    a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
    b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement

2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
    a. Modbus RTU (Two-Wire RS-485)

C. Each transmitter shall be powered by 115VAC (± 10%) at 60Hz unless specifically shown on the drawings as being powered by 24VDC (± 15%). Each transmitter shall retain its programmable settings in non-volatile memory.

D. Each sensor and corresponding transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the transmitter shall be protected from the sun such that direct sunlight will not shine on the display.

E. All transmitters shall be waterproof and made from corrosion resistant materials.

F. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 FLOW PROCESS MEASUREMENT DEVICES

A. MAGNETIC FLOW METER

1. Materials

    a. All mounting hardware shall be 316 stainless steel, the instrument enclosure and the spool mag shall be rated NEMA 4X, the flow sensor liner shall be hard rubber, and the electrode material shall be Hastelloy.

    b. Spool size shall be as specified on the drawings.

c. All applications with flow element below grade where no de-watering means or in submersible applications shall provide the flow element as NEMA 6P (IP-68).

d. Transmitter shall be integral or remote to the flow element as shown on the P&ID’s.

2. Design and fabrication

a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate. The meter shall use a pulsed DC magnetic field excitation.

b. Provide flanged end connections per ANSI B16 rated for piping system operating and test conditions.

c. Operating pressure: 150 psi.

d. Operating temperature: 32-150°F.

e. Grounding requirements: per manufacturer requirements. Typically, inlet and outlet grounding rings of same material as electrode.

f. When the transmitter is remote to the flow element, provide cable between flow element and transmitter. Coordinate with the installer the length of the cable required. No splices in any way will be allowed.

g. Complete zero stability shall be inherent to the meter system. The system shall have a programmable low flow cutoff.

h. Empty pipe detection to prevent false measurement when pipe is empty or partially filled.

i. Forward and reverse flow measurement and totalization as well as net flow totalization.

j. 4-20mA DC isolated output into maximum 800 ohms. Signal shall be programmable to indicate forward and/or reverse flow.

k. Provide a dry contact output for flow direction indication.

l. Provide a programmable frequency output for flow totalization.

m. ± 0.5% accuracy for flow rates above 1 fps.

3. Acceptable Manufacturers
   a. Siemens SITRANS F 5100W.
   b. Endress+Hauser Promag W 400.
   c. Rosemount 8700.
   d. ABB WaterMaster.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

B. Install all transmitters five feet above floor level. Install in a location that is easily accessible and visible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

2. Test the process measurement system for proper operation at low, mid, and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 71 13

SECTION 40 72 23 – RADAR LEVEL METERS

PART 1 - GENERAL

A. Radar level instruments are used to provide continuous noncontact level measurement of the process. The radar instrument consists of a transmitter, a radar antenna, and a receiver.

1.2 ACTION SUBMITTALS

A. Product Data:
   A. Dimensional Drawings
   B. Materials of Construction
   C. Measurement Accuracy
   D. Range and range ability
   E. Enclosure Rating
   F. Classification Rating

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each transmitter shall be equipped with means to transmit process measurement information to the plant SCADA system.

  A. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
    a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)

  B. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
    a. Hart Protocol

B. Each radar transmitter shall be loop powered unless specifically shown on the drawings as being powered externally. Each transmitter shall retain its programmable settings in non-volatile memory.

C. Each radar transmitter shall be capable of being programmed through a Bluetooth connection.

D. Each sensor and corresponding transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the transmitter shall be protected from the sun such that direct sunlight will not shine on the display.

E. All transmitters shall be waterproof and made from corrosion resistant materials.

F. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 RADAR LEVEL MEASURING SYSTEM

  A. The radar level measuring system shall be setup as a single loop powered transducer/transmitter assembly. For hazardous locations, the transmitter shall be rated for the area of classification that it being installed in and it shall be installed with an appropriate intrinsically safe barrier to guarantee the circuit may not normally or abnormally release sufficient electrical or thermal energy to cause ignition of a flammable or combustible atmospheric mixture.

  B. All transducer/transmitter assemblies shall be rated IP68 for permanent submergence. Transmitters shall have an LCD display and shall be programmable by Bluetooth. A remote display shall be provided if no LCD is available on the transmitter.

  C. The transducer shall be encapsulated in chemical and corrosion resistant material and shall be hermetically sealed. The antenna supplied (horn or rod) shall be per the recommendation of the manufacturer. It shall be capable of operating from -40°F to 140°F. The transducer shall be compatible with the level range as indicated on the Contract

Drawings. As a minimum, the transducer shall be capable of measuring a range of 40 feet with ≤ 0.2-inch accuracy.

D. Coordinate with the mechanical installers the method of installing the radar system (flanged or threaded connection). It is critical that the radar level measuring system be installed according to the manufacturer's installation guidelines. Install shield sections if required. Keep the radar emission cone free of interference from pipes, beams, pouring liquids, etc. Locate the assembly away from side walls of tanks or vessels.

E. Each transmitter shall provide a 4-20mA output signal that is programmable to a user desired level range.

F. Provide a software package by the same manufacturer as the radar system that is used to commission and maintain the system. The software shall be able to configure the system, view radar echo profiles and modify the programming to suppress false echo.

G. Manufacturers:
   a. Siemens
   b. Vega
   c. Endress + Hauser

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

B. Install all analyzers/transmitters five feet above floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

A. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

B. Test the process measurement system for proper operation at low, mid, and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 72 23

SECTION 40 72 76 – LEVEL SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Level switches provide point level measurement of the process.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Dimensional Drawings
   2. Materials of Construction
   3. Measurement Accuracy
   4. Range and range ability
   5. Enclosure Rating
   6. Classification Rating

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each level switch system shall typically consist of a sensor and an output contact.

B. Each level switch shall be equipped with means to transmit process measurement information to the plant SCADA system.

1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
   a. Form C dry type contacts rated for 10A up to 250VAC.

C. Each level switch shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the level switch shall be protected from the sun such that direct sunlight will not shine on the display.

D. All level switches shall be waterproof and made from corrosion resistant materials.

E. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 LEVEL PROCESS MEASUREMENT DEVICES

A. FLOAT SWITCHES

1. Float switches shall consist of a mechanical switch, hermetically sealed in a plastic casing, freely suspended at the desired height from its own cable. When the liquid level reaches the float switch, the casing will tilt, and the mechanical switch will change state.

2. The casing shall be constructed of polypropylene with the sheathed cable extruding from the casing. The cable shall be three conductors, made specifically for underwater use and heavy flexing service.

3. The float switch shall have a 10A resistive rating up to 250VAC.

4. Weight and buoyancy shall be such that contaminants like a cake of grease will not result in the float switch changing operating level more than one inch.

5. A NEMA 4X 316SS junction box shall be supplied for termination of the float cable(s) allowing for conventional wiring and conduit to be run from the junction box to a control panel. It shall have terminal blocks for the required number of circuits and shall accept sealed fittings.

6. Float switch cables shall be suspended in a manner that provides minimum strain to the cable and will not damage it. This is typically achieved with a stainless-steel cord support grip or strain relief grip as manufactured by Kellems. When support grips are used, a stainless-steel hook shall be installed for hanging the support. All screws, fasteners, boxes, and grips shall be 316SS. In no way are any steel or galvanized steel components allowed.

7. The float cable length shall be long enough for easily removing the float from the water for testing and long enough to reach its termination junction box.

8. If the float switch is to be installed in a classified area, an appropriate intrinsically safe barrier shall be utilized to guarantee the circuit may not abnormally create an ignition.

9. Manufacturers:
   a. Flygt ENM-10.
   b. Or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

2. Test the process measurement system for proper operation at low, mid, and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 72 76

SECTION 40 73 13 – PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Pressure and differential pressure gauges provide continuous pressure measurement of the process for local indication.

1.2 ACTION SUBMITTALS

A. Product Data:
1. Dimensional Drawings
2. Materials of Construction
3. Measurement Accuracy
4. Range and range ability
5. Enclosure Rating
6. Classification Rating

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. All gauges shall be waterproof and made from corrosion resistant materials.

2.2 PRESSURE PROCESS MEASUREMENT DEVICES

A. General

1. All inline pressure instruments shall be supplied with isolation ball valve and bleed needle valve for each measurement point. Valve materials shall be selected based upon the properties of the liquid or gas and the atmosphere.

2. Unless otherwise indicated on the Contract Drawings, pressure process measurement devices shall measure process pressure relative to atmospheric pressure (gauge pressure).

3. Pressure process measurement devices which are to measure differential pressure shall have the appropriate inlet and outlet ports and isolation and bleed valves for each port.

4. All pressure instrumentation shall be properly mounted, ideally in locations that are easily accessible and viewable. Supply all appropriate mounting poles, plates, and accessories such that each instrument is properly supported and mounted.

B. Pressure Gauges

1. Pressure gauges shall be 4-1/2 inches in diameter with white laminated dials and black graduations. Windows shall be shatterproof glass acrylic. Gauges shall have a blowout disc and be encased in phenolic, steel, or cast iron. Measuring element shall be a stainless-steel bourdon tube with welded, stress-relieved joints. Socket shall have wrench flats. Movement shall be rotary geared stainless-steel material. Gauges shall perform as a liquid-filled gauge in a dry gauge and fight against vibration and pulsations. Gauges shall be calibrated to read in applicable units. Accuracy shall be plus and minus 1/2 percent range to 150 percent of the working pressure or vacuum of the pipe or vessel to which they are connected.

2. Acceptable Manufacturers
   a. Ashcroft 1279.
   b. Or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems.

B. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 73 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 73 36 – PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Pressure and differential pressure switches are used to prove a process condition for interlocking or alarming.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Dimensional Drawings
   2. Materials of Construction
   3. Measurement Accuracy
   4. Range and range ability
   5. Enclosure Rating
   6. Classification Rating

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each pressure switch shall be equipped with contacts shall be rated for a minimum of 5 Amps at 120 VAC.

B. Each pressure switch shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the pressure switch shall be protected from the sun such that direct sunlight will not shine on the display.

C. All pressure switch shall be waterproof and made from corrosion resistant materials.

2.2 PRESSURE PROCESS MEASUREMENT DEVICES

A. General

1. All inline pressure instruments shall be supplied with isolation ball valve and bleed needle valve for each measurement point. Valve materials shall be selected based upon the properties of the liquid or gas and the atmosphere.

2. Unless otherwise indicated on the Contract Drawings, pressure process measurement devices shall measure process pressure relative to atmospheric pressure (gauge pressure).

3. Pressure process measurement devices which are to measure differential pressure shall have the appropriate inlet and outlet ports and isolation and bleed valves for each port.

4. All pressure instrumentation shall be properly mounted, ideally in locations that are easily accessible and viewable. Supply all appropriate mounting poles, plates, and accessories such that each instrument is properly supported and mounted.

B. Pressure Switches

1. For unclassified locations, pressure switches shall be housed in a NEMA 4X enclosure. For classified locations, pressure switches shall be housed in a NEMA 7 enclosure.

2. Gauge and Differential pressures switches shall be diaphragm-actuated, dual adjustable, with SPDT snap action switch. Contacts shall be rated for a minimum of 5 Amps at 120 VAC. The dead band shall be adjustable up to 60 percent of full scale. Set points shall fall between 20 and 80 percent of the adjustable range. The diaphragm shall be Buna-N, unless

otherwise indicated, and the lower housing shall be brass with a 1/4-inch bottom sensing connection, unless otherwise indicated.

3. Acceptable Manufacturers
    a. Ashcroft Series B (Gauge) and D (Differential).
    b. Or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

B. Install all pressure switches five feet above floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

2. Test the process measurement system for proper operation at low, mid, and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 73 36

SECTION 40 73 63 – DIAPHRAGM SEALS

PART 1 - GENERAL

1.1 SUMMARY

A. Diaphragm seals provide a means to measure pressure while keeping the pressure sensing device isolated from the process. These are commonly used for services that would plug the small passages in the pressure sensing device.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Dimensional Drawings
   2. Materials of Construction
   3. Measurement Accuracy
   4. Range and range ability
   5. Enclosure Rating
   6. Classification Rating

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each diaphragm seal shall consist of a diaphragm, fill fluid, and piping connection for mounting of transmitter. Each unit shall be arranged and designed to directly transmit the process measure by means of fluid through an opening in the lower housing to a pressure sensing device attached and sealed to the upper housing. Diaphragm seals shall be factory assembled to the pressure sensing device.

B. All diaphragm seals shall be made from corrosion resistant materials.

2.2 PRESSURE PROCESS MEASUREMENT DEVICES

A. Annular Ring Diaphragm Seals

1. The pressure sensing ring shall measure pressure for 360 degrees around the full inside circumference of the pipeline. The sensing ring shall also be clamped into the body for the full radial width of the sensor. Pressure shall be transmitted to the gauge by a locked in and sealed fluid such as ethylene glycol or silicone oil. The annular seal shall be factory-assembled to the corresponding pressure instrument and be factory filled. The assembly shall be shipped with a tag stating, "Do not disassemble for installation."

2. The annular ring shall be rated for ASME classes 150 and 300. It shall be constructed of carbon steel. Instrument connection shall be ¼" NPT.

3. The inside diameter of the sensor shall be the same as the mating pipe for a full uninterrupted flow. There shall be no dead ends or crevices, and flow passage shall make the sensor self-cleaning. The sensor shall have an auxiliary tapped and plugged port to allow connection of other equipment.

4. Wetted parts (liner) shall be capable for continuous duty handling a slurry containing 15 percent solids in a hydrocarbon oil similar to kerosene at temperatures up to 225 degrees F.

5. Acceptable Manufacturers:
   a. Ashcroft model 80.
   b. Red Valve Series 48W.
   c. Noshok Type 40

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

2. Test the process measurement system for proper operation at low, mid, and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 73 63

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 76 00 – PROCESS GAS ANALYTICAL MEASUREMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Process gas analyzers provide continuous gas measurement of the specified gases in the process or ambient environment.

1.2 ACTION SUBMITTALS

A. Product Data:
  1. Dimensional Drawings
  2. Materials of Construction
  3. Measurement Accuracy
  4. Range and range ability
  5. Enclosure Rating
  6. Classification Rating
  7. Power
  8. Output options

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each process measurement system shall consist of a sensor and an analyzer. Where shown on the drawings, the analyzer may be utilized for multiple sensors. When an analyzer is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.

B. Each analyzer shall be equipped with means to transmit process measurement information to the plant SCADA system.

1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
    a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
    b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement

2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
    a. Modbus RTU (Two-Wire RS-485)

C. Each analyzer shall be powered by 24VDC (+/- 15%) unless specifically shown on the drawings as 115VAC (+/- 10%). Each analyzer shall retain its programmable settings in non-volatile memory.

D. Each sensor and corresponding analyzer shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the analyzer shall be protected from the sun such that direct sunlight will not shine on the display.

E. All analyzers shall be waterproof and made from corrosion resistant materials.

F. All sensors shall be rated for permanent submersion and shall be corrosion resistant.

2.2 GAS ANALYSIS PROCESS MEASUREMENT DEVICES

A. Each gas sensor/analyzer shall be provided with a NEMA 4X rating for unclassified areas and NEMA 7 ratings (explosion-proof) for classified areas and specifically listed for Class 1, Division 1 groups B, C and D.

B. All gas analyzers shall be 24VDC powered. Unless specifically indicated otherwise on the drawings, provide for each building with any gas analyzers a 24VDC power supply housed inside of a NEMA 4X enclosure.

C. All analyzers shall have a 4-20mA output for each gas being detected capable of driving a 500-ohm loop load. All analyzers shall have programmable relays rated at 5A up to 230VAC for wiring to a PLC, Horn and/or beacon.

D. Furnish and install a sampling pump module where required to draw an air sample into the analyzer sensor.

E. Infrared type sensors shall be supplied when available for gases being detected.

F. Provide maintenance and calibration equipment necessary to maintain and calibrate the gas analyzers for a period of three years.

G. The following gas detection configurations shall be considered as standard unless shown otherwise on the drawings:
   1. Combustible Gas: 0-100% LEL

H. The gas analyzers shall be furnished with a display that indicates the measured gas level.

I. Acceptable Manufacturers:
   1. MSA Ultima X Series
   2. Det-tronics

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

B. Install all analyzers five feet above floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

2. Test the process measurement system for proper operation at low, mid, and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 76 00

SECTION 432010 - PUMPS, GENERAL

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each pump Section. Unless otherwise indicated, the single Manufacturer shall be the Manufacturer of the pump.

D. Single Manufacturer: Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 013300 – Contractor Submittals.

B. Shop Drawings: Shop drawings shall contain the following information:
   1. Pump name, identification number, and specification Section number.
   2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable frequency drive.
   3. The Contractor shall require the Manufacturer to indicate on the performance curves the limits recommended for stable operation without surge, without cavitation, and without vibration (except vibration within specified allowable limits). The stable operating range shall be as wide as possible based on actual hydraulic and mechanical measurements taken during the factory performance tests of the pumps.
   4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
   5. Data, in accordance with Division 11 and 26 for the electric motor proposed for each pump.
   6. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.
   7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
   8. Complete electrical schematic diagram.

C. Operation and Maintenance Manual: The Manual shall contain the required information for each pump Section.

D. Anchorage: The manufacturer shall provide anchor bolt design calculations in accordance with the latest edition of CBC, stamped and signed by a licensed professional engineer in the State of California.

E. Spare Parts List: A Spare Parts List shall contain the required information for each pump Section.

F. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.

G. Certifications
   1. Manufacturer's certification of proper installation.
   2. Contractor's certification of satisfactory field testing.

1.3 QUALITY ASSURANCE

A. Factory Testing: The following tests shall be conducted on each indicated pump system:
   1. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.
   2. Pump Systems: All centrifugal pump systems 100 hp and larger shall be tested at the pump factory in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute, Inc. Tests shall be performed using the complete pump system to be furnished, including the motor.
   3. For motors smaller than 100 hp, the Manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:
      a. Hydrostatic test data
      b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
      c. Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
      d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.
   4. Factory Witnessed Tests: All pumps, variable speed drives, and motors, 150 hp and larger shall be factory-tested as complete assembled systems and may be witnessed by the Owner and Engineer. The use of one of each type project motor and variable frequency drive for testing all pumps shall be acceptable. The Contractor shall give the Engineer a minimum of 4 weeks notification prior to the test. All costs for Owner and Engineer expenses shall be borne by the Contractor and shall be included in the bid price. Such costs shall include travel and subsistence for two people excluding salaries. Test results shall be submitted to the Engineer and no equipment shall be shipped until the test data have been approved by the Engineer.

B. Warranty: Unless otherwise specified, each pump shall be supplied with manufacturer’s standard warranty of one (1) year from substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the Manufacturer's standard equipment.

B. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine, or encroach on the service factor.

C. No cavitation shall be allowed in pumps operating within the stable operating range for the specified operating conditions. For the purposes of this provision, cavitation shall be recognized and accepted as being present in a pumping unit if cavitation noise can be perceived either by the human ear or by acoustic instruments or devices. The presence or absence of cavitation noise shall be verified by the Owner during both the factory performance tests of the pumps and during operation of the pumps up to the end of the warranty period. To assist in revealing potential cavititation during the factory performance tests, in addition to all other required tests, the Manufacturer shall force the pumps to operate at the specified minimum net positive suction head available for each of the following conditions: minimum flow rate, design flow rate and head, and maximum flow rate.

D. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors, variable frequency controls if required, necessary mountings, and appurtenances.

2.2 MATERIALS OF CONSTRUCTION

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of austenitic ductile iron, conforming to ASTM A 439 - Specification for Austenitic Ductile Iron Castings, or equal.
2. Bronze pump impellers shall conform to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, or B 584 - Specification for Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316.
4. All anchor bolts, nuts, and washers that are not buried or submerged shall be hot-dip galvanized, unless otherwise specified in individual pump Sections. Buried or submerged bolts, nuts, and washers shall be stainless steel in accordance with Section 055000 – Metal Fabrications.

2.3 PUMP COMPONENTS

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings Dimensions.

B. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for other process fluids shall be lubricated as indicated.

C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

D. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.

E. Drains: All gland seals, air valves, cooling water drains, and drains from variable frequency drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the Contractor shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

G. Stuffing Boxes: Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the Manufacturer's suggested materials best suited for the specific application. For drainage and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.

1. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
    a. Shaft speeds - up to 2500 rpm
    b. Temperature - up to 500 degrees F
    c. pH range - 0 to 14.
2. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.

H. Mechanical Seals: Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Type	Manufacturer
Wastewater Pumps	Double seals: John Crane Type L Double; Borg-Warner Type L Double; Chesterton
Abrasives, Grit, or Lime Slurry Pumps	Double seals: John Crane Type I (hard faces); Borg-Warner Type L (hard faces); Chesterton
Chemicals or Corrosive Liquid Pumps	Single seals: John Crane Type 8-1, 9; Borg-Warner Type Q, QB; Chesterton
Water Pumps Hot and Cold	Single seals: John Crane, Type I, 21; Borg-Warner Type L; Chesterton

I. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the Manufacturer, in order to maintain reliable seal performance.

J. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number. Dimension and flow information shall be in metric units, followed by English units in parentheses.

B. Solenoid Valves: The pump Manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.

C. Gauges: all pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
   1. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
   2. Pressure and compound gauges shall be provided in accordance with Section 40 73 13 – Pressure Gauges.

D. Spare Parts: One full set of all recommended spare parts shall be provided with each set of pumps.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
   1. Installation of the equipment.
   2. Inspection, checking, and adjusting the equipment.
   3. Startup and field testing for proper operation.
   4. Performing field adjustments to ensure that the equipment installation and operation comply with the specified requirements.

B. Instruction of the Owner’s Personnel
   1. Where required by the individual pump Sections, an authorized training representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to instruct the Owner’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least two years' experience in training. A resume for the representative shall be submitted.
3. Training shall be scheduled a minimum of three weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.
5. The training materials shall remain with the trainees.
6. The Owner may videotape the training for later use with the Owner personnel.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.

B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The Contractor shall provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Materials and equipment shall be coated as required in Section 098000 – Protective Coatings.

3.4 FIELD TESTS

A. Where required by the individual pump Sections, each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.

B. The following field testing shall be conducted:
1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.
2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
4. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is indicated.

C. Field testing will be witnessed by the Engineer. The Contractor shall furnish 5 days advance notice of field testing.

D. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

E. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

F. The Contractor shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water which the Owner will bear. If available, the Owner’s operating personnel will provide assistance in field testing.

END OF SECTION 432010

THIS PAGE INTENTIONALLY BLANK

SECTION 432513 – DRY PIT SCREW CENTRIFUGAL PUMPING UNITS

PART 1 – GENERAL

1.01 DESCRIPTION

A. GENERAL: This specification is for the furnishing and installation of dry pit screw-type centrifugal immersible pumps for pumping raw sewage (potentially containing rags and other fibrous material) without clogging.

1. The pumping units shall be manufactured by Hidrostal H5K-S, or equal, as described in this specification and contract drawing no. 83M801. Any proposed substitutions shall be in accordance with the provisions of this specification and shall be approved by the Engineer and the Owner.

2. The Manufacturer/Supplier (through the Contractor) shall provide four (4) identical pumps of the type and model specified. All four (4) units will be installed with one (1) of the units serving as an operational standby.

B. SITE LOCATION: The Owner's existing Mesa Lift Station is located in Beaumont, California. Refer to Vicinity Map on the cover sheet of contract drawings.

1.02 UNIT RESPONSIBILITY

A. GENERAL:

1. The Pump Manufacturer shall be responsible (through Contractor) for providing the complete pump, including the motor, base and all required pump components for installation by the Contractor.

2. During the submittal process, the Pump Manufacturer shall provide a notarized certificate stating that all equipment and materials for the pump(s) will be provided by the Pump Manufacturer.

3. Pump Manufacturer shall attend pump start-up and provide field services for assistance to the Contractor. Refer to Par. 1.14 of these specifications.

4. Contractor shall be responsible for ensuring that all equipment operates properly and in accordance with the specifications.

5. Contractor shall have overall responsibility for the furnishing, delivery, installation and successful operation of the specified pumping units.

B. COMPATIBLE EQUIPMENT

1. All combinations of manufactured equipment which are approved under this specification shall be entirely compatible and the Contractor and the listed manufacturer shall be responsible for the compatibility and successful operation of the various components of the units conforming to the specified requirements.

2. All necessary mounting, couplings and appurtenances shall be included with each unit.

3. All materials employed in the pump equipment shall be suitable for the intended application and shall be high grade commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

4. Pumps shall be fabricated, assembled and operate in full conformance with the drawings, specifications, engineering data and approved shop drawings.

5. The Contractor shall be responsible for furnishing and installing all pumping equipment; and shall also be responsible for furnishing and installing all miscellaneous equipment items required to provide complete, properly functioning pumping units; all in accordance with the Contract Documents.

1.03 PUMP DELIVERY AND CONTRACT COMPLETION SCHEDULE

A. The specified Hidrostal pumping units having screw-type impellers for sewage pumping typically have long fabrication and delivery schedules, in some cases up to thirty (30) weeks after approval of the pump submittals. This pump manufacturing and delivery time has been accounted for in the allocated contract completion time for this project. The Contractor shall be responsible for adjusting his overall construction schedule in order that the pumping units can be manufactured, shop tested, delivered, installed and field tested within the specified Contract Completion Schedule.

1.04 ALTERNATE PUMP MANUFACTURER REQUIREMENTS

A. SUBMISSION REQUIREMENT FOR ALTERNATE MANUFACTURERS

1. The Engineer, on behalf of the Owner, has performed a detailed evaluation of the specified pumping units for this project. Submission of an alternate pump selection and manufacturer (other than alternate manufacturer/model which may be stated herein) shall require that the Contractor provide the Owner with a $6,500 cash deposit and complete submission within ten (10) calendar days following Award of Contract to cover engineering expenses related to the detailed review for an “approved equal” status.

2. Submission of a bid proposal with an alternate pump manufacturer is at the bidder’s risk since no detailed review or “equal” status determination of any alternate pump or manufacturer (other than provided for under this specification) will be performed prior to the bid opening.

B. NON-APPROVED PUMP MANUFACTURER:

1. Submission of a non-approved manufacturer may be subject to rejection.

2. Authority for determination of "approved equal" pump and manufacturer, including conformance with Specification requirements, shall rest solely with the Owner.

3. In the event that the Contractor's submission of an alternate pump selection and manufacturer is rejected, Contractor shall submit the specified pump and manufacturer at no additional cost to the Owner.

4. No additional contract time extension will be granted for the Owner's review and evaluation.

1.05 SITE EXISTING CONDITIONS

A. GENERAL: The existing Mesa Lift Station is a 5,000 GPM nominal capacity wet well/dry pit installation currently containing three (3) Flygt pumps with direct mounted motors.

1. Refer to contract drawings for required demolition and reconfiguration.

2. The proposed Hidrostal pumping units shall be oriented and installed to accommodate both the proposed design layout and existing field conditions.

B. MEASUREMENTS:

1. General: Contractor shall be responsible for obtaining and documenting all necessary field measurements prior to submittal of shop drawings. Contractor's field measurements shall be provided with the project shop drawings.

2. Motor Cables: Measure and verify the required length of motor cables for each unit to point of electrical connection since splicing of cables will not be allowed.

1.06 HYDRAULICS AND SYSTEM OPERATION

A. GENERAL: There will be two (2) primary operating scenarios: The interim condition (which is expected to be the scenario upon initial start-up) and some years thereafter; and the ultimate scenario.

B. DESIGN FLOWS: The current peak flow (dry weather) is estimated at 2020 GPM. There is a proposed new development that will increase the peak flow in the near future. A ballpark estimate for near-term design peak flow is 2250 GPM. Ultimate condition design peak flow is 5105 GPM.

C. PUMPING UNITS: The proposed pumping units are equally sized. During the interim condition, two of the four proposed pumping units are expected to operate. For the ultimate condition, three of the four units will operate in combination, with the fourth unit acting as a standby unit, although units may operationally alternate to provide approximate equal use and wear.

D. FORCE MAINS: The existing force main (FM) is 12-in. diameter PVC; a proposed 16-in. PVC force main will to be constructed in parallel with the 12" dia. force main. The existing 12-in. force main is considered under-capacity for near-term peak flow conditions. Therefore, for the interim condition, use 16-in. dia. FM and isolate the existing 12-in. dia. force main. In the future, once normal peak flow to the lift station exceeds 3450 GPM, the 12-in. dia. force main will be placed in parallel with the 16-in. force main operating in combination.

1.07 QUALITY ASSURANCE

A. PUMP DESIGN AND MANUFACTURING:

1. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.

2. Manufacturer shall provide evidence of at least five (5) installations in which identically sized equipment has provided satisfactory performance for a minimum of five (5) years in a similar application.

3. No consideration will be given to an individually sized pump that has not been commercially available for five (5) years.

B. ISO 9001 COMPLIANCE:

1. To insure a consistent high standard of quality, the manufacturer of this pumping equipment shall comply with the requirements of the ISO 9001 Quality and such compliance shall be verified by an independent certification agency approved by the International Organization for Standardization.

2. Documentation shall be submitted for approval showing compliance with this requirement, and the equipment will not be released for shipment until approved.

C. CONTRACTOR EXPERIENCE: Contractor shall provide evidence of at least five (5) installations in which similarly sized equipment has been successfully installed by its firm and provided satisfactory performance in a similar application.

1.08 SUBMITTALS

A. GENERAL:

1. Prior to commencing pump fabrication or production, Contractor shall submit a digital copy of submittal data for all proposed material and equipment to the Owner for review and approval.

2. Submittals shall include all product data, shop drawings, performance specifications, pump performance curves, submergence requirements, net positive suction head required, etc. for the specific pumping units.

3. The pump submittal data shall be prepared, in its entirety, by the equipment manufacturer. Shop drawings prepared by the manufacturer's sales representative, fabrication shop or other than the listed manufacturer shall not be acceptable.

4. No additions or modifications to the manufacturer's submittal shall be accepted, with the sole exception of a cover letter provided by the manufacturer's local Representative.

B. QUALIFICATIONS: Submit experience qualifications in accordance with paragraph 1.07.A.2.

C. CATALOG DATA: Provide detailed data on pumps, motors and all related appurtenances.

D. PERFORMANCE DATA CURVES: Provide performance data curves showing head, capacity, horsepower demands, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guaranteed point.

E. CERTIFIED PUMP CURVES: Provide certified pump curves showing head, capacity, horsepower demands, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guaranteed point. Certified pump curves shall show compliance with the minimum efficiency at the design point indicated in Part 2 of the specification.

F. FIELD DATA AND MEASUREMENTS: For existing lift stations, provide data for all field measurements pertinent to the pumping unit design and installation. Indicate field measurements taken on the shop drawings with an asterisk (*) on the dimension.

G. SHOP DRAWINGS: Provide shop drawings showing plan and section views for the pumping unit showing all pertinent dimensions.

1. Drawings to be to suitable scale.

2. Show all weights; particularly total weight of unit for installation and removal.

3. Show suction stand details.

4. Show suction and discharge piping details.

5. Show base and necessary elevations and dimensions to match existing conditions.

6. Show anchoring requirements and include anchor bolt design and calculations signed by a professional engineer in the State of California.

H. MOTOR:

1. Provide manufacturer's catalog information, motor drawings and operating characteristics, nameplate data and efficiency characteristics, and maximum starts per hour.

2. Wiring diagrams shall be provided showing power and control wiring terminal connections including wiring identification and color coding.

3. Show motor cable lengths to be provided on the shop drawings. Also indicate required length of cables per field measurements.

4. Junction box sizing for power and control wiring connections shall be provided.

5. Information shall indicate compliance with requirements specified in the Electrical Code.

I. FIELD INSTALLATION INSTRUCTIONS: Provide field installation recommendations, instructions and drawings for the entire pumping unit, including bases.

J. OPERATING AND MAINTENANCE MANUALS:

1. Provide three (3) hard copies and one (1) digital copy of the Operating and Maintenance (O&M) Manual.

2. Include maintenance instructions, assembly views, lubrication instructions and replacement parts lists.

3. Recommendations and instructions for initial start-up and testing.

K. FIELD VALIDATION TESTING: Provide a written plan for the pumping unit portion of the system validation testing and operational demonstrations.

1.09 CERTIFICATION OF INSTALLATION

The Contractor shall provide a letter from the Manufacturer/Supplier of the pumping units to the Owner confirming that all pumping equipment was inspected, operation checked and installation approved; together with an executed "Certification of Proper Installation". Contractor shall coordinate with Owner and Pump Manufacturer/Supplier regarding scheduling for installation.

1.10 ACCEPTANCE TESTING

After completion of the pump installation, acceptance testing of the pumping units shall be performed in accordance with Part 3 of these specifications.

1.11 PUMP GUARANTEE

A. GENERAL: The Contractor shall be deemed to guarantee that all materials and workmanship in the items furnished hereunder shall fully meet all requirements of the Contract Documents, including the Technical Specifications.

B. GUARANTEE PROVISIONS:

1. The guarantee shall apply to all units furnished under the contract.

2. Under the guarantee, the Manufacturer/Supplier (through the Contractor's bond) shall be deemed to have agreed to replace all items made necessary by defects in materials or workmanship in the items supplied by him, and that become evident to the Owner within two (2) years after the date of final payment hereunder; and the Contractor shall pay for all work necessary to remove, restore and replace such defective item to full serviceability and to full compliance with the requirements of the Bidding Documents including the Technical Specifications until expiration of said two (2) year period.

3. Any required replacement shall be made promptly upon receipt of written orders for the same from the Owner, and if not made, Owner may secure the service of others to do this work in accordance with the contract provisions.

4. The guarantee and agreements shall be secured by the Contract Performance Bond provided by the Contractor and shall be in accordance with the General Conditions; and the duration of the guarantee shall be two (2) years.

1.12 DELIVERY, STORAGE AND HANDLING

A. GENERAL: The pumping unit Manufacturer/Supplier shall perform the following:

1. After shop testing and before dismantling pumping equipment for shipment, all wiring and mechanical connections shall be match marked or tagged to ensure proper field assembly.

2. Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling and storage.

   a. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, and type or grade.

   b. Complete packing list and bills for material shall be included with each shipment.

   c. Each item of equipment shall be tagged or marked with the same identification number or mark as shown on the packing lists and bills of material.

B. PROTECTION:

1. After delivery and unloading of the pumping unit/equipment by the Contractor, Contractor shall protect materials and equipment from exposure to the elements and keep dry at all times.

2. Handle and store equipment to prevent damage in accordance with Manufacturer/Supplier instructions.

C. SHIPPING AND DELIVERY:

1. Equipment shall be fabricated, shipped and delivered by Manufacturer/Supplier to the project site where unloading and storage will be performed by the Contractor.

2. Installation Contractor shall coordinate all details of delivery with the Manufacturer/Supplier and the Owner.

3. Manufacturer/Supplier shall provide copies of packing lists and bills of lading to the Contractor on or before the equipment is shipped.

D. INSPECTION:

1. Manufacturer/Supplier representative shall be present at time of unloading equipment to ensure that unloading is properly performed, components delivered are complete and components are properly placed in storage.

2. After all equipment has been delivered and prior to installation by the Contractor, Manufacturer/Supplier representative shall perform an inventory inspection of equipment delivered to the project site to confirm that delivery is in fact, complete.

1.13 PRODUCTION SCHEDULE

Within thirty (30) calendar days after date of award of contract, Manufacturer/Supplier (through Contractor) shall furnish Owner with a preliminary pump production schedule. The schedule shall include starting dates and time allocated for engineering, manufacturing, shop testing and shipment. An updated firm production schedule shall be provided to the Owner within ten (10) days following final approval of shop drawings and submittals. Any changes in the production schedule thereafter shall be promptly conveyed to the Contractor and Owner through an updated production schedule.

1.14 MANUFACTURER/SUPPLIER SERVICES

A. GENERAL:

1. All costs pertaining to the MINIMUM manufacturer’s services as specified herein shall be included in the contract price; and at no additional cost to the Owner.

2. Manufacturer shall designate a qualified Manufacturer’s representative who shall be available both by phone and in person to provide technical information relative to the specific equipment being furnished; including installation.

3. The services described herein are for inspection of delivered equipment, observation of field installation, field acceptance testing and in-service checks as described elsewhere in this specification.

4. For purposes of the paragraph, a work day is defined as 8-hour period at the site, excluding travel time.

5. The Owner may require that the manufacturer’s services described herein be furnished in up to eight (8) separate trips to the project site.

B. INSPECTION OF EQUIPMENT DELIVERY: The service representative of the manufacturer shall be present at the site for a minimum of one-half (1/2) working day and perform tasks described in Paragraph 1.12.D.

C. INSTALLATION ASSISTANCE: Assist the Contractor, as required, at the project site during critical installation phases. Inspect installation of all pumping units after they are set in place and provide “Certificate of Proper Installation”: Two (2) working days.

D. START-UP AND FIELD ADJUSTMENT: The service representative of the manufacturer shall be present at the project site to assist Contractor with initial start-up and any required field adjustments as necessary to assure that the pumps are in satisfactory operating condition: One (1) working day.

E. ACCEPTANCE TESTING: Attend pumping unit acceptance testing; perform field testing and documentation as required and per Part 3 of these specifications: Three (3) working days.

F. IN-SERVICE CHECK: Between the eleventh and seventeenth month following field testing and acceptance of the pumping units by the Owner, an in-service check shall be performed per Part 3 of these specifications. The service representative of the Contractor and pump Manufacturer/Supplier shall coordinate with the Owner, attend the in-service check, document all check and test results and provide the Owner with a written summary report: One (1) working day.

PART 2 – PRODUCTS

2.01 DESCRIPTION

A. GENERAL:

1. All manufactured pump related items to be provided under this specification shall be new and of current manufacture.

2. All pumping units shall be provided from one manufacturer as specified.

3. All materials for the pumping units shall be suitable for its intended use and service.

4. Materials not specifically called for shall be high grade; free from any defects and imperfection that might offset serviceability of the product for the purpose for which is was intended.

B. SCHEDULE: The pump(s) and pump-related materials specified herein shall be provided for installation by the Contractor compatible with the specified Contract Completion Schedule. Contractor and pump Manufacturer/Supplier shall closely coordinate regarding the schedule.

2.02 PUMP PERFORMANCE AND CONDITIONS OF SERVICE

A. GENERAL:

1. The screw centrifugal pumps shall conform to the applicable Hydraulic Institute (HI) standards.

2. The pumps shall be designed for continuous operation and will be operated continuously under normal service.

3. The pumps shall be compatible with the design system-head curve(s).

4. The hydraulic efficiencies listed for each pump are the minimum acceptable and shall be guaranteed by the manufacturer.

B. OPERATION CRITERIA:

1. Maximum Pump Speed: 1800 RPM

2. Motor Speed: 1798 RPM

3. Maximum Motor Size: 168 HP (VFD Rated)

4. Minimum Shut-off TDH: 384-feet

5. Maximum Brake Horsepower:

   a. 160 HP (within operating range)

   b. 140 HP (at Primary Design Point)

6. Design Condition Points:

    a. Primary Design Point: 1750 GPM @ 228-feet TDH;
       Min. Eff = 72.0%

    b. Secondary Point 1: 1500 GPM @ 243-feet TDH;
       Min. Eff = 68.7%

    c. Secondary Point 2: 2600 GPM @ 183-feet TDH;
       Min. Eff = 74.5%

C. PUMP CRITERIA:

1. Minimum Suction Diameter: 10″

2. Minimum Discharge Diameter: 5″

3. Minimum Non-Compressible Solids Passage: 3.75″

4. Minimum B-10 Bearing Life: 50,000 Hours

D. NPSH REQUIRED: The maximum Net Positive Suction Head (NPSH) required for the full operating range specified in Par. 2.02.B.7 shall not exceed 11.5-ft.

2.03 PUMPING UNITS

A. DESIGN:

1. The basic design shall be a single-passage, clog-free pump, utilizing a screw-centrifugal impeller. The overall pump design shall combine high efficiency, low required NPSH, a large solid passage, and the ability to handle rags or other fibrous materials without clogging.

2. The hydraulic design of the impeller shall combine the action of a positive displacement screw with the action of a single-vane centrifugal impeller to provide a single, non-bifurcated flow stream with only gradual changes in flow direction.

    a. The leading edge of the impeller vane shall blend into the impeller body in such a way that any rag or other fibrous material caught on the leading edge and folded over both sides of the vane will be unfolded and released as the textile follows the flow stream through the pump.

    b. The impeller flange or impeller shall contain a spiral groove on the rear face so that any solids in the pumped media are discharged from the space between the back plate and the rear of the impeller.

3. In order to maintain optimum running clearances along the entire length of the impeller to maintain design hydraulic efficiencies, the geometry of the impeller and suction piece shall be conical, so any axial adjustment of the impeller will cause the clearance between the impeller vane and suction piece to change uniformly along the entire length of the impeller. Designs

incorporating curved, or combination curved/conical impeller and suction piece are not acceptable because in such designs clearances cannot be adjusted uniformly over the full length of the impeller.

4. Suction and discharge flanges shall be drilled to meet ANSI 125 lb. bolting.

B. MATERIALS OF CONSTRUCTION:

1. The pump volute, back plate, suction cover, and impeller flange shall be of closed-grained cast iron, ASTM A48-CL30.

2. Suction liner materials of construction:

   a. For pumps with a regulable liner, the suction piece shall be externally adjustable to compensate for wear by means of three (3) stainless steel regulating screws so that the necessary running clearances between the liner and impeller can be maintained for optimum hydraulic efficiency.

   b. Pumps without a separate suction liner are not considered equal or acceptable.

3. Impeller Materials of Construction: For Hidrostal Model H5K-S:

   a. Suction Liner: Hardened Liner

   b. Wet End Components: Regulable High Chrome Iron Liner

   c. Impeller Material: High Chrome Iron

   d. All impellers shall be dynamically balanced

4. All materials shall conform to the following specifications:

   a. Cast Iron: ASTM A48-CL30

   b. Ductile Iron: ASTM A536-72

   c. High Chrome Iron: ASTM A532-CL.III Type A, minimum 450 Brinell hardness.

   d. Impeller stainless steel: Abrasion Resistant Stainless Steel; minimum 16% Chromium, minimum 235 Brinell hardness.

C. IMMERSIBLE MOTOR:

1. Motor Design:

   a. Motor to be manufactured by same manufacture as the pump.

   b. Motors shall be of explosion-proof design, approved by Factory Mutual for uses in Division 1, Class I, Groups C&D, and hazardous locations.

c. The motors shall be of the immersible type, suitable for full-load, continuous operation either completely dry or fully submerged in the pumped liquid of up to 65-foot depths. Motors shall be of the "air-filled" type, to optimize efficiency, with stator and rotor housed in a watertight chamber containing only air. Motors of the "oil-filled" type, with stator and rotor immersed in oil or motors which circulate the pumped media through internal cooling media channels, ports, or jackets are not equal or acceptable.

d. Motors shall incorporate a separate heat-exchanger circuit, with a shaft-mounted cooling pump circulating oil from a jacket surrounding the stator housing to a heat-exchanger surface cast into the pump back plate. The circulating oil shall transfer excess motor heat directly to the pumped media inside the pump volute, without the need of submergence. The circulating oil shall provide adequate motor cooling at any continuous power output up to an including rated powers in an ambient temperature of up to 40°C.

e. Motor stator windings and leads shall be Class H wire, insulated with moisture-resistant Class F insulation for operation at temperatures up to 155 degrees Celsius. The complete system shall be considered a Class F insulation system.

f. Motors shall have a stator varnish applied by the "vacuum-pressure impregnation" method to ensure thorough and complete varnish penetration. The stator shall be heat-shrink into the stator housing.

g. Motor cable-entry sealing assembly shall consist of the following components to ensure a positive, redundantly watertight seal:

   i. The sealing components shall be mechanically isolated from cable strains by a two-piece restraining clamp, which will securely grip the cable above the moisture-sealing components and bear any mechanical forces applied to the cable.

   ii. The cable moisture seal shall consist of an elastomer grommet, prevented from extruding past the cable by stainless-steel retaining washers on either side. The grommet shall be compressed tightly against the cable outside diameter (and the entry assembly inner diameter) by a screwed follower gland.

   iii. Each individual conductor shall be interrupted by a solid-copper isolation dam to prevent wicking of moisture through the conductor stands.

   iv. The cable insulation shall be sealed by an epoxy poured into the cable entry and totally encapsulating the stripped-back insulation and the individual copper dams. This poured epoxy seal shall also function as a redundant seal for the cable outside diameter.

   v. The cable free end shall be sealed from moisture-entry during shipping, storage, and prior to connection to the control panel by a plastic sleeve securely clamped over the cable end.

vi. Motors which use only a compressed grommet gland, or only a poured epoxy seal, without benefit of redundancy of both types together are not considered equal or acceptable.

h. Shaft sealing shall be independently-mounted, tandem mechanical seals contained in an oil chamber that is formed as an intrinsic part of the motor frame and allows the seals to be completely submerged in and lubricated by the oil bath.

i. The mechanical seal nearest the bearing shall utilize carbon/silicon carbide faces and shall isolate the seal cooling oil from the motor frame.

ii. The mechanical seal nearest the impeller shall be a rubber bellows-type construction (except for U and T size motors, which shall be stainless steel bellows-type construction) with the bellows designed to prevent contaminants from contacting the stainless-steel spring which loads the seal face. The seal faces shall be a solid tungsten carbide rotating face running against a solid silicon carbide stationary face. Seals with both faces of similar materials, or seals with bonded, soldered, or converted face surfaces are not equal or acceptable.

iii. The mechanical seal nearest the impeller shall be contained in a seal chamber formed by the impeller flange and a recess cast into the motor frame. To prevent debris from entering the chamber and to prolong the mechanical seal life, a flush port shall be provided so that an optional external water flush can be supplied directly into the seal chamber.

4) The mechanical seal nearest the impeller shall be isolated from contaminants in the pumped media by a labyrinth-fit between the backside of the impeller back shroud and into the back plate, to minimize debris reaching the shaft seal.

i. The thrust bearings shall be designed to take the full axial load of the impeller.

j. Motors shall be immersible, 3 phase, 60 cycle, 168 HP, 1798 RPM.

2. Motor Protection Devices:

a. Motor size (third digit of motor code): U, T

b. Thermal Protection: Thermostats (N/C Klixon type); or thermistors

c. Bearing Temperature Protection: Normally closed thermal switch

d. Dry Chamber Float Switch: Normally closed float switch

3. Protection Device Specifications:

a. Thermostats (N/C Klixon type): Three normally closed thermal sensors embedded in the stator windings, wired in series, will open a protective circuit if winding temperature exceeds rated operating temperature. These sensors automatically reset when winding temperature has cooled to a safe operating temperature. Thermostats shall not be used on VFD operation.

b. Thermistors: Three thermistor type thermal sensors embedded in the stator windings, wired in parallel, will send a signal to an external relay, which will open a protective circuit if winding temperature exceeds rated operating temperature. Upon tripping, the external relay must manually reset and the cause of the overheating investigated before the motor can be returned to operation. When the motor is operated on VFD, thermistor type thermal protection must be used.

c. For Motors Equipped with Bearing Temperature Protection: One normally closed thermal sensor is provided in close contact to the thrust bearings of the motor. The sensor will be wired to shut down the motor if bearing temperature exceeds rated operating temperature.

d. For Motors Equipped with a Dry Chamber Float Switch: The motor shall be equipped with a normally closed float switch in the dry portion of the motor, to shut down the motor in the event that water should enter the dry portion of the motor.

e. Pump Manufacturer shall provide to the Electrical Contractor a four channel intrinsically safe relay module such as the RK Electronics IS-R series for the connection of the **oil conductivity sensor**, bearing temperature sensor, and the dry chamber float switch. In addition, the Pump Manufacturer shall provide a thermistor motor protection relay such as the Siemens Sirius 3RN2 series.

4. Conductivity Probe: All motors shall be fitted with a conductivity probe to monitor the moisture content of the oil in the chamber between the outer and the inner mechanical seals. The probe shall be wired to a separate protective circuit, which, when connected to a conductivity-sensitive relays in the control panel, will trip an alarm if moisture content of the oil indicates a failure of the outer mechanical seal.

D. DRY PIT IMMERSIBLE MOUNTING: for Hidrostal Model H5K-S:

1. Mounting Option: Concrete Piers

2. Base Material: Painted Steel Soleplate

3. Elbow or Suction Stand Material: Cast Iron Suction Stand

4. Vertical Pier Mounting with Suction Elbow: The pump manufacturer shall provide a fabricated steel soleplate of sufficient thickness to support the entire weight of the pump and motor.

a. The pump manufacturer shall provide the Contractor with drawings and data so that the Contractor can provide two formed concrete piers to properly support the soleplate and pump assembly, while providing sufficient clearance to ensure that the suction does not in contact with the floor.

b. The concrete pump piers shall be formed such that there is no impedance to access the pump piping connections or inspection covers.

c. The pump shall be supplied complete with a cast iron suction elbow which shall be fitted within the confines of the concrete piers.

d. The cast elbow shall include an integral hand-hole cleanout, the interior surface of which shall follow the contours of the suction elbow.

E. PUMP COATING: Pump coating shall be Tnemec N69 Hi-Build Epoxoline II or Owner approved equal; minimum two (2) coats, 5.0 mils DFT each (10 mils DFT total).

F. NAMEPLATES

1. Each pump shall have a Type 316 stainless steel plate permanently attached by stainless steel screws or rivets to the pump frame into which the following information shall be impressed, engraved or embossed:

    a. Manufacturer's name

    b. Pump size

    c. Serial number

    d. Impeller diameter

    e. Capacity

    f. Head rating

    g. Speed

    h. Bearing numbers

2. Nameplates shall include information unique to each item of equipment and device to identify its function as described herein.

3. Function nameplates shall be approximately 1-inch by 3-inches if made separately.

4. Letters of function titles shall not be smaller than 1/4-inch high.

G. SPARE PARTS: Provide one (1) set each of the following spare parts:

1. Impeller

2. Liner

3. Associated O-rings

H. PUMP, MODEL AND MANUFACTURER: Pumping shall be Model H5K-S submersible/Immersible units as manufactured by Hidrostal.

PART 3 – EXECUTION

3.01 PUMP EQUIPMENT FACTORY TESTING

A. GENERAL: All pumps shall be factory-tested in accordance with these specifications. Certified test results shall be submitted to the Owner for approval prior to shipment.

B. ASSEMBLED UNITS: Tests shall be performed on the actual assembled unit over the entire operating range on the certified performance curve. Prototype model tests will not be acceptable.

C. CERTIFIED PUMP CURVES: Certified pump curves shall reflect data secured during actual test runs and shall be signed by a responsible representative of the pump manufacturer. Test reports and procedures shall conform to applicable requirements of the Hydraulic Institute Standards.

D. ACCEPTANCE GRADES: Grade 1B per ANSI/HI 14.6

3.02 INSTALLATION

A. GENERAL:

1. Pumping equipment and related appurtenances shall be installed in accordance with the approved instructions, procedures and shop drawings submitted by the pump manufacturer/supplier and as indicated on the Contract Drawings.

2. Manufacturer/Supplier shall provide the following as summarized below and detailed in Part 1:

   a. Inspection of pumping unit equipment upon delivery to project site.

   b. The necessary installation recommendations, guidelines and drawings to Owner and Contractor.

   c. The required Manufacturer services during construction.

   d. "Certification of Proper Installation" confirming that all pumping equipment was installed, inspected, checked, adjusted and tested in accordance with the manufacturer's recommendations and requirements specified herein.

3. The pump manufacturer shall furnish the services of factory-trained personnel as required to examine the installation, supervise start-up of equipment installed, and repair the equipment at no additional expense to the Owner.

B. ALIGNMENT AND SETTING: Equipment shall be field checked to verify proper alignment and setting, and operation as specified. Equipment shall be secured in position and fixed neatly in appearance.

C. FOUNDATIONS: The Contractor shall furnish and install the reinforced concrete pier supports and all necessary embedment items, anchor bolts, nuts, washers, anchor tie rods, other material necessary for anchoring the equipment to the reinforced concrete pier supports.

D. PIPING AND APPURTENANCES: Furnish and install piping and appurtenances associated with the pumping equipment in accordance with other sections of the Technical Specifications and Contract Drawings.

E. COORDINATION: Contractor shall be responsible for coordinating all applicable aspects of the project with the pump manufacturer/supplier including, but not limited to equipment installation procedures and requirements, specific materials to be furnished, scheduling of materials deliveries, overall construction schedule, equipment storage and protection requirements, and equipment testing requirements.

3.03 FIELD TEST TESTING

A. GENERAL: Field testing shall be performed, as approved by Engineer, to verify performance of all installed equipment. The manufacturer's Field Service Engineer shall assist in the proper conduct of pumping unit field tests.

1. The pump units shall perform in the field as shown on the certified pump curves furnished by the Contractor.

2. Tests shall also demonstrate operation without cavitation, vibration, overheating of moving parts, and excessive noise.

B. FIELD TEST AND ADJUSTMENTS:

1. The Contractor and the Manufacturer's Field Service Engineer shall conduct proper pumping unit field acceptance tests.

2. Tests shall demonstrate operation of the pumping units without cavitation, vibration and excessive noise.

3. Make necessary corrections to achieve smooth pump operation for all units.

3.04 SYSTEM VALIDATION TESTING

A. GENERAL: Manufacturer/Supplier shall assist the Contractor in performing operational demonstration and system validation testing for the specified sewage pumping units.

B. SCHEDULE: Operational demonstrations and validation testing shall not commence for any equipment item or system until all related structures, piping, electrical, instrumentation, control and like work has been installed, tested, and connected in compliance with the pertaining requirements specified elsewhere in the Specifications.

C. PUMPING UNIT FIELD TEST SCOPE: Each pumping unit shall be tested in automatic mode for not less than 48-hours, with no interruptions.

1. Pump discharge valves shall be throttled to simulate design condition(s).

2. Flow may be measured via pitot tube or by use of Owner's mag meter.

3. Contractor to provide calibrated test pressure gauges.

4. Record pumping unit flow, discharge pressure, motor voltage and motor amperage at least four (4) separate times at 6-hour minimum intervals during test period.

   a. Maintain neat and accurate records of test data and results.

   b. Provide copy of data and results to Owner together with a summary report.

D. INSPECTION AND SUPERVISION: Contractor and Pump Manufacturer/Supplier shall jointly perform operational demonstrations and system validation testing under continuous inspection by the Owner. Technical representative(s) of the equipment manufacturer shall be present at the start of the operational demonstrations, will examine their equipment at least twice near the beginning and end of the validation tests, and will supervise the start-up and adjustment procedures.

E. CORRECTIONS OF DEFECTS: Immediately correct all pump installation related defects and malfunctions disclosed by demonstrations and validation tests using approved methods and new materials for repairs as required.

3.05 IN-SERVICE CHECK

A. GENERAL:

1. As part of the work, an in-service check of the pumping units is required to be validation tested. Refer to Par. 1.14.F.

2. Manufacturer/Supplier (through Contractor) shall provide all necessary equipment to conduct the validation testing as per Paragraph 3.04.C.

B. IN-SERVICE CHECK REQUIREMENTS:

1. Checks shall be detailed and complete and shall be performed under the observation and to the satisfaction of the Owner.

2. Provide documentation of results and summary report as per Par. 3.04.C within 10-days following the in-service check.

3. All costs for the in-service check shall be included in the contract price.

END OF SECTION 432513

SECTION 461500 – ALUMINUM BASIN COVERS (ADD ALTERNATE)

PART 1 - GENERAL

1.1 SUMMARY

A. This specification is for a fully engineered, substantially airtight, aluminum cover structure comprised of panels, and beams.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, and equipment to provide a complete, installed system of fixed and removable, custom fit, flat aluminum covers. The Tank Cover system includes cover panels, structural supports, and attaching hardware.

B. The following shall be covered with an aluminum cover as outlined in this specification:

1. Emergency Storage Basin – Dimensions as shown in plans. The covers shall free span the entire clarifier and shall not require any internal supports.

1.3 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide aluminum basin covers as manufactured by:

1. Hallsten Corporation (Basis-of-Design)
2. CST Industries
3. Or equal

1.4 ENGINEERING

A. A submittal shall be provided to the engineer prior to the beginning of fabrication. The submittal shall include:

1. Complete structural calculations showing the governing stresses in all members, connections, anchoring to concrete walls, and detailed shop drawings. Preliminary drawings shall be stamped by the cover manufacturer's Professional Engineer. Final Drawings and calculations shall bear the stamp of State of California Professional Civil Engineer.
2. Manufacturer's standard guarantee.
3. A letter of certification signed and sealed by a registered Professional Civil Engineer in the State of California confirming that the aluminum cover is in full compliance with the plans and specifications including any testing provisions included therein.

1.5 QUALIFICATIONS

A. Manufacturer: Shall be a company specialized in providing engineered aluminum covers for wastewater treatment tanks/troughs for at least ten (10) years. When requested by the Engineer, submit written evidence to show experience qualifications and adequacy of plant capability and facilities for performance of contract requirements.

B. Erector: Regularly engaged for at least ten (10) years in the erection of aluminum covers for wastewater treatment tanks.

C. Welders: Qualified within the past two (2) years in accordance with AWS.

1.6 PERFORMANCE

A. Span: The clear span length of the cover shall be as noted in drawings.

B. Width: The inside width of the cover shall be as noted in drawings.

C. Distributed Design Live Load and Deflection: All structural components shall be designed to support the dead weight of the structure, plus a live load of 50 pounds per square foot of surface. The maximum deflection of any component under this load shall not exceed L/240 of the span of that component. In no event shall the dead load deflection exceed the rise of any component in order to avoid surface ponding.

D. Concentrated Live Load: The structural components shall be designed to support a 400-pound load on a 6" X 6" area located anywhere on the surface of the structure without permanently deforming the tested area.

E. Design Stresses: All allowable design stresses in structural aluminum shall be in accordance with the "Specifications for Aluminum Structures" for building-type structures by the Aluminum Association.

F. Skid Resistance: The cover shall possess an integral non-skid surface and no exposed area of cover system wider than one inch shall be without ribs/non-skid surface. The aluminum-decking surface of the structure shall be Hallsten's Deck Slat, which is ribbed to provide an aggressively non-skid surface. The edges of adjacent deck slats shall double interlock so that the slats shall act together. The decking surface shall be manufactured form 6061-T6 alloy. The Manufacturer of the non-skid surface shall demonstrate in writing satisfactory performance for a minimum period of 10 years in the wastewater industry for the intended purpose. This surface shall not be achieved by the use of paint, adhesive tapes, sand blasting or any other means other than an extruded process.

G. Chemical Resistance: Panels shall be fabricated entirely of 6061-T6 corrosion resistant aluminum extrusions. Every panel to beam connection shall be chemical resistant and will not weaken or corrode and will interlock. A mechanical and replaceable Santoprene seal shall isolate the cover perimeter from the concrete wall. No foam tape or caulk shall be allowed.

H. Configuration: The aluminum cover shall be composed of panels and beams. All panels shall interlock with the adjoining beam and panels without the use of threaded fasteners. Uplift of each panel will be resisted with the use of an integral latch system. The weight of an individual panel shall not exceed 150 pounds. Each removable panel shall be easy to remove without disruption of adjacent panels and the lifting force required shall not exceed the dead weight of the panel.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum: All aluminum used in the fabrication of the cover shall be alloy 6061-T6. All plate shall be alloy 6061-T6. Material shall be new and of top quality.

B. Welding Electrodes: Welding shall be with electrodes of an alloy, which shall produce welds with strength and corrosion resistant characteristics compatible to the base metal.

C. Fasteners: All fasteners between aluminum components shall be stainless steel or structural plastic. Aluminum shall be isolated from dissimilar materials by means of a stainless steel spacer or an elastomeric isolator. Beams and panels shall be fastened to concrete using stainless steel drill in place anchor bolts.

D. Steel Accessories: No carbon steel components shall be used.

E. Seals: A mechanical and replaceable Santoprene seal shall isolate the cover perimeter from dissimilar materials such as concrete and steel. No foam tape or caulk shall be allowed for isolation of cover system.

F. Access Hatch Panels: Access to any location under the cover shall be gained through integral gear hinged access hatches. The Access Hatch Panels shall have the identical properties as the rest of the aluminum cover including loads, deflection and slip resistance specifications. The access-hinged panels shall be the full panel width. The length of the access panel shall be clearly indicated on drawings. Hinged panel components including hinges, decking and lifting handles shall be extruded 6061-T6. While in the closed position the hatches will be completely flush therefore posing no tripping hazard. In the open position the panel shall lie flat on the cover and will not need a hold open device.

G. Handles: Handles shall be an integral flush mounted aluminum and incorporated into the non-skid deck slat.

2.2 FABRICATION AND WORKMANSHIP

A. Workmanship: The quality of workmanship shall be equal to the best general practice in modern structural fabrication shops. Workmanship, fabrication, and shop connections shall be in accordance with the latest edition of ANSI/AWS D1.2 "Structural Welding Code - Aluminum".

B. Experience: The manufacturer must furnish adequate evidence of a minimum of ten (10) years of ongoing experience in the manufacture of similar structures.

C. Preparation for Welding: All components to be welded shall be free of dirt, grease, and other contaminants and shall fit up properly for sound welding. Surfaces to be welded may not be cut with oxygen. Sawing, shearing, or machining may be used.

D. Welding Procedures: All welding shall be with an inert gas shield arc process. Machine settings shall be developed with test welds of the same material, alloy and geometry as the work pieces and samples will be tested destructively.

PART 3 - EXECUTION

3.1 TESTING

A. Loads: After installation the cover structure will be tested for conformance with the deflection limits. A load of 400 pounds will be placed as directed by the Engineer and the maximum deflection created by the load will be measured.

B. Prequalified Shop Testing: MANUFACTURER shall perform a prequalified shop air tightness test and certification for the cover components proposed. This test shall be performed in accordance with the "Procedural Standards for Testing, Adjusting and Balancing of Environment System" as published by the National Environmental Balancing Bureau (NEBB) on cover components of not less than 80 square feet. Said test shall be conducted and witnessed by a NEBB certified technician. The method of testing, test apparatus and proposed contents of the test report shall be submitted to the Engineer for approval. Subsequent to the receipt of Engineer's approval, the Manufacturer shall set up testing protocol and schedule the test. A report of the test shall be prepared by the certified technician and shall be sealed with the NEBB seal. The report shall include a description and illustration of the test components, a description and illustration of the test apparatus and a report of the results. The cover shall maintain an air intrusion leakage rate not to exceed 0.2 cfm per square foot at an applied negative pressure of 0.2 inches of water column for a five-minute duration.

3.2 DELIVERY AND INSTALLATION

A. Delivery: Delivery of the components of the structure shall be made to a location nearest the site that is accessible to over the road trucks, unless otherwise specified.

B. Storage: The manufacturer shall be responsible for jobsite storage of the delivered components. The components shall be stored off the ground on level surface in such a manner as to prevent damage.

C. Installation: The manufacturer shall furnish such personnel, tools, equipment, and materials as required to install the cover using the recommended procedure. The manufacturer shall also provide a written certification to the Engineer that the cover has been installed according to the manufacturer's requirements.

D. Contractor Installation: The cover manufacturer can provide installation instructions, on site supervision, and inspection if desired. The manufacturer shall also provide a written certification to the Engineer that the cover has been installed according to the manufacturer's requirements.

END SECTION 461500

SECTION 462433 – MANHOLE GRINDER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Grinder Manhole, Installation Frame & Lifting Guides, and Controller.

1.2 REFERENCE STANDARDS

A. Equipment shall, as applicable, meet the requirements of the following industry standards.

B. ASTM International (ASTM):
   1. ASTM A36 - Carbon Steel Plate.
   2. ASTM A536 - Ductile Iron Castings.
   3. ASTM A48 - Gray Iron Castings.
   4. ASTM A564 Grade 630 condition H1150 (17-4) stainless steel

C. American Iron and Steel Institute (AISI):
   1. AISI Type 1020 Steel
   2. AISI Type 1045 Steel.
   3. AISI Type 4130 - Heat Treated Alloy Steel.
   4. AISI Type 4140 Heat Treated Alloy Steel.
   5. AISI Type 18-8 Stainless Steel
   6. AISI Type 303 Stainless Steel.
   7. AISI Type 304 and 304L Stainless Steel.
   8. AISI Type 316 and 316L Stainless Steel.

D. Society of Automotive Engineers (SAE):
   1. SAE Type 660 Bearing Bronze.

E. National Electrical Manufacturer's Association (NEMA) Standards.

F. National Electrical Code (NEC).

G. Underwriters Laboratory (UL and cUL).

H. International Electrotechnical Commission (IEC).

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer is documented as being engaged in the sale of similar products for over forty-years.
   2. Manufacturer is single supplier for equipment listed in this section.
   3. Manufacturer's Service Center is located domestically for repairs and upgrades.
   4. Manufacturer supports Renew Program, providing new factory-built replacements of selected products for install without requirement to return existing equipment.
   5. Manufacturer supports Preventative Maintenance Program, providing inspection and

service of equipment by Manufacturer's Factory Technicians.
6. Manufacturer stocks all non-custom spare Parts.

B. Regulatory Requirements:
1. Manufacturer is U.L. listed for the construction of controller.

C. Certifications:
1. Manufacturer's management system is ISO9001 certified.

1.4 SUBMITTALS

Submittal documentation is provided for approval in ".pdf" format.

A. Product Data:
1. Product description text.
2. Performance curves or capacity tables.
3. Catalog data.

B. Shop Drawings
1. General arrangement of installation.
2. Product Configuration.
3. Assembly
4. Wiring diagrams

C. Operation and Maintenance Manuals:

Submit one copy of a suitable operation and maintenance manual with shipment of product. An electronic version shall be supplied to create additional copies.
1. The manuals shall include but not be limited to the following: Equipment descriptions, operating instructions, drawings, troubleshooting techniques, recommended maintenance schedule, recommended lubricants, and recommended replacement parts list.

D. Anchoring Design:
1. Submit anchoring calculations and design stamped by a professional engineer licensed in the state of California.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging, Shipping, Handling, and Unloading
1. Packaged in containers or on skids suitable for normal shipping, handling, and storage.
2. Protected from rain, snow, impact, and abrasion while in the possession of the carrier.

B. Acceptance at Site
1. Contractor shall review the contents of the shipment at time of delivery and promptly notify the carrier and supplier of any discrepancies.

C. Storage and Protection
1. Equipment to remain in the packaging provided by the supplier until it is installed.
2. Equipment to be stored in a dry environment between 40 and 100 degrees F.

D. Waste Management and Disposal

1. Contractor shall be responsible for discarding all packaging materials in an environmentally friendly manner and in accordance with local regulations.

1.6 WARRANTY

A. 12-month Limited Warranty
   1. Manufacturer submits a standard twelve-month limited warranty document clearly identifying the scope, term, and exclusions from the coverage.

1.7 SERVICE

A. Supplier supports product with multiple programs options available.
   1. Service Center located domestically for repairs and upgrades.
   2. Renew Program: Provides new factory-built replacements of selected products for install without requirement to return existing products.
   3. Preventative Maintenance Program: Inspection and service of equipment by Factory Technicians.
   4. Spare Parts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. JWC Environmental Inc,

B. Or Approved equal

2.2 GRINDER MANHOLE

Fiberglass reinforced polyester (FRP) below ground manhole connects into pipeline ahead of pump location and allows installation of an open-channel grinder for solids reduction. Provides above ground access to the grinder.

A. Basis of Design:
   1. Muffin Monster Manhole (as manufactured and supplied by JWC Environmental Inc
      a. 72-inch barrel diameter with ½ minimum wall thickness able to withstand static load of 150 lb-ft per foot of depth with less than ¼-inch deflection.
      b. Interior surface smooth isophthalic gelcoat integral to the laminate not applied as spray or secondary process.
      c. Interior surfaces white for easy inspection for toxic molds and mildew.
      d. Supplied with ½-inch thick expanded polystyrene bead board for placement on concreate slab under manhole.
      e. 2-inch NPT FRP conduit tap for electrical cables.
      f. Equipped with four (4) AISI 316 stainless steel mounting brackets

B. Inlet and Outlet Connections
   1. Neoprene boot and stainless steel bands for connection to influent and effluent pipe.
   2. Pipe size: 30-inch (RCP)

C. Manway-Traffic
   1. Concentric dome able to withstand 16,000 lb vertical dynamic wheel load plus lateral

forces.
2. Provides 60-inch diameter access.
3. For use with cast iron manhole cover (Provided by others)

D. Integral open-channel
1. Width sized to accommodate grinder and required hydraulics.
2. Depth sized to accommodate grinder and required hydraulics.
3. Provides 4-inch deep recess for grinder for improved hydraulic performance.

E. Fiberglass Ladder
1. Meets or exceeds OSHA General Industry Standards, Part 1910.27 for “Fixed Ladders”.
2. Non-slip traction surface.

2.3 OPEN-CHANNEL GRINDER

Reduces solids conveyed in a wastewater stream to a size that is non-detrimental to downstream equipment. Grinder uses side rail with flow channel and specially designed fingers with a shape to create a pressure gradient increasing flow capacity and maximize capture of solids. Grinder uses low speed and high torque drive with two counter-rotating shafts stacked with intermeshed individual cutters and spacers supported on both ends of each shaft with mechanical seal and bearing cartridges, driven by an electric motor and speed reducer. Grinder will be subject to infrequent submerged conditions.

A. Basis of Design:
1. Channel Monster Flex model# CMF3624 (Wipes-Ready) as manufactured and supplied by JWC Environmental Inc
   a. Maximum Design Flow Capacity: 9,065 GPM (13.05 MGD)
   b. Cutter Stack and Perforated Drum Height: 36 inches
   c. Perforated Drum Diameter: 24 inches
   d. Cutter Stack Configuration: Multi Zone-Staggered and Helical
      1) Zone 1 (Grit) Stack Height: Nominal 6-inches
      2) Zone 2 (Working) Stack Height: Nominal 30-inches

B. Cutter Assembly
1. Stack Configuration: Multi-Zone-Staggered and Helical Stack
   a. Cutters and spacers stacked with two defined zones, each with its own unique cutter and spacer type, thickness, stacking configuration, and material throughout zone. Zone 1 cutters for high abrasion resistance and Zone 2 cutter for shearing and particle size control.

Zone 1-Grit Zone
2. Material Zone 1: Alloy Steel.
   a. Cutters: Through hardened to 45-52 HRC
   b. Spacers: Through hardened to 34-52 HRC.
3. Cutters-Zone 1 (6-inch Grit Zone)-Staggered Stack
   a. 7-tooth Cam style, .438-inch effective thickness, 4.710-inch diameter. Designed specifically for waste streams containing heavy volumes of solids.
   b. Precision ground individual cutter elements with a thickness tolerance of +.000/ -.001.
   c. Keyed to shaft with hexagon opening.

   Spacers-Zone 1 (6-inch Grit Zone)

d. Smooth O.D. .446-inch thick, Alloy Steel.
e. Precision ground individual spacer elements with a thickness tolerance of +.001/ -.000.
f. Keyed to shaft with hexagon opening.

Configuration-Zone 1 (Grit Zone)

g. Cutters and spacers form 3-inch nominal stack height
h. Cutters stacked staggered with every other cutter's teeth aligned to minimize absorbed torque requirement and maximize cutter tooth force.

Zone 2-Working Zone

4. Material Zone 2: Alloy Steel.
    a. Cutters: Through hardened to 45-52 HRC
    b. Spacers: Through hardened to 34-52 HRC.
5. Cutters-Zone 2 (Working Zone)-Helical Stack
    a. 17-tooth Serrated Cam style, .438-inch thick, 4.730-inch diameter. Designed specifically for waste streams requiring focused reduction of disposable and non-disposable cloth products or wipes.
    b. Multiple serrations located on outside diameter edge of cutter teeth create punctures or perforations in the cloth or paper materials creating a confetti type cut that inhibits reweaving of the material with hair and other solids.
    c. Precision ground individual cutter elements with thickness tolerance of +.000/ -.001
    d. Keyed to shaft with hexagon inner profile.

    Spacers-Zone 2 (Working Zone)

    e. Knurled O.D. .446-inch thick.
    f. Knurled diamond pattern on outside diameters surface.
    g. Precision ground individual spacer elements with a thickness tolerance of +.001/ -.000.
    h. Keyed to shaft with hexagon opening.

A. Intermediate Shaft Collar with Vertical Support
    1. Intermediate shaft collars, AISI 304 stainless steel housing, SAE 660 bearing bronze bushing and 17-4 PH rotating element.
    2. Vertical Support with adjustable brackets for mounting of the shaft collars.
    3. Vertical Support, AISI 304 stainless steel.
    4. AISI 304 stainless steel grease fittings and grease lines attached to shaft collars and routed through Vertical Support.
    5. Bushing and rotating element factory lubricated with high temperature marine grade grease.

B. Mechanical Seal and Bearing Cartridges-Severe Duty
    1. Seals and bearing incorporated into a cartridge style design requiring no external seal flush or lubricants to operate wet or dry.
    2. Rated for maximum operating depth: 346 feet (150 psi).
    3. Secondary lip seal with grease barrier.
    4. Dynamic and Static seal faces to be Tungsten carbide with 6% nickel binder.
    5. Cartridge bushing and housing are AISI 304 stainless steel.
    6. O-rings to be Viton (Fluorocarbon).

C. Shafts
    1. 2-inch hexagon heat treated AISI 4140 alloy steel.

2. Minimum tensile strength of 170,000 psi.
3. Supported on either end by Mechanical Seal and Bearing Cartridges.
4. Cantilevered designs are not acceptable.

D. Compression Nut and Spring Disk
1. Compression Nut
a. Stack nut sized to provide proper clamping force to secure cutting stack at manufacturer's recommended torque.
2. Spring Disk
a. Spring element provides a preload of the cutter stack maintaining a clamping force securing the cutter from movement.
~~b.~~ Disk, or seat element prevents overloading of cutter stack by limiting distance spring element can be compressed.

E. End Housings, Side Rails, Top Cover, Bottom Cover, and Gaskets
1. End Housings
a. Cast integral bushing deflector directs solids away from Mechanical Seal and Bearing Cartridge bushings.
b. Directional flow arrows on side of housings indicate correct installation orientation for solids discharge.
c. Cast ASTM A536-84 65-45-12 ductile iron.
2. Side Rails
a. Evenly-spaced horizontal fingers and flow channels. Flows channel create additional open area through grinder increasing flow capacity. Horizontal fingers direct solids toward cutters by creating a pressure differential towards the cutters.
b. Shape of flow fingers creates a pressure gradient to force solids to cutters and minimize water head loss.
c. Fingers and flow channel are positioned on the upstream side of the grinder terminating even with the center of the cutter proving free discharge.
d. Side rails with flow channel running the entire length of the side rail are not allowed.
e. Cast ASTM A536-84 65-45-12 ductile iron.
3. Screen Side Rail
a. Opening allows Solids Diverter perforated drum to be positioned close to cutter's tooth tip.
b. Cast ASTM A536 65-45-12 ductile iron.
4. Top Cover:
a. Manufacturing identification plate mounting.
b. Cast ASTM A536-84 65-45-12 ductile iron.
5. Bottom Cover:
a. ASTM A36 Steel.
6. Gaskets:
a. Cork and neoprene rubber.

F. Transfer Gears with integral interlocking lobes
1. Heat treated and hardened AISI 4140 alloy steel.
2. Number of teeth on gears creates ratio of cutter tip speed on low speed shaft to cutter tip speed of highspeed shaft greater than 0.90 and less than 1.00 to promote cleanout of processed material in cutting stack.

G. Couplings

1. Low Speed Coupling
    a. Two-piece 3-jaw interlocking design.
    b. Hardened AISI 4140 alloy steel
2. High Speed Coupling
    a. Type L 3-jaw with elastomer
    b. Buna-N spider.

H. Lifting Eyes
1. Drop forged Steel
2. Rated for 1300 lb
3. Designed for lift of grinder.

I. Speed Reducer
1. Grease lubricated cycloidal design Cyclo Series 6000 with 29:1 reduction ratio.
2. Manufacturer: Sumitomo Machinery Corporation of America.

J. Motor
1. XPNV Immersible Explosion Proof Motor: Baldor Electric Company.
    a. Installed Horsepower: 5 HP.
    b. Motor Service Factor: 1.15.
    c. Minimum Motor Efficiency (at Full Load): 91 percent.
    d. Minimum Motor Power Factor (at Full Load): 76.

    Performance:
    e. Grinder Peak Torque with Reducer: 1,665 lb-ft.
    f. Grinder Peak Force at Cutter Tip: 8,493 lbf.
    g. UL rated NEMA 6P, Class I, Div. 1 Groups C&D, Class II Div. 2, Groups F&G, Class III Div. 1.
    h. Manufacturer rating of 40 consecutive days of submergence at a maximum depth of 40 feet.
    i. Capable of operating in air 100 percent of time with no external cooling required.
    j. No fan cooling during operation.
    k. Utilize ceramic shaft seal requiring no oil lubrication.

K. Identification:
1. Corrosion resistant nameplate affixed to top cover of Grinder.
2. Nameplate Information: Manufacturer's name and address, Model No., Serial No., Capacity, Max. psi, Weight, Manuf. Date.

L. Finishes:
1. Paint Coatings for Ferrous Materials: Prepared to SSPC-SP6 (Commercial Blast Cleaning) and coated with minimum 6 to 8 mils TDFT (total dry film thickness) of an aliphatic acrylic polyurethane paint in the color Hunter Green.
2. Paint Coatings for Previously Coated Components (Motors, Speed Reducers, etc.): Prepared to SSPC-SP1 (Solvent Cleaning) and SSPC-SP2 (Hand Tool Cleaning) and coated with minimum 6-8 mils TDFT (total dry film thickness) of an aliphatic acrylic polyurethane paint in the color Hunter Green.

2.4 SOLIDS DIVERTER

Cylindrically formed stainless steel perforated screen drum mounted vertically between two housings containing mechanical seals and bearing cartridges, driven by an electric motor and speed reducer. Solids captured on the surface of the rotating screen drum are conveyed to the cutters of the Grinder. Low RPM of screen drum allows cutters of Grinder multiple tooth passes to remove and reduce solid. Vertical brush sweeps perforations of screen drum keeping orifices free from buildup.

A. Perforated Screen Drum
   1. Screen cylindrically formed using ½ inch diameter holes (Orifices) with a nominal 50% open area across the surface of the screen.
   2. Maximum area of each orifice: 0.2 square-inches.
   3. Screen deburred AISI 316 stainless steel.
   4. Trunnions top and bottom of drum ASTM A564 Grade 630 condition H1150 (17-4) stainless steel.

B. Mechanical Seal and Bearing Cartridges-Severe Duty
   1. Seals and bearing incorporated into a cartridge style design requiring no external seal flush or lubricants to operate wet or dry.
   2. Rated for maximum operating depth: 346 feet (150 psi).
   3. Secondary lip seal with grease barrier.
   4. Dynamic and Static seal faces to be Tungsten carbide with 6% nickel binder.
   5. Cartridge bushing and housing are AISI 316 stainless steel.
   6. O-rings to be Viton (Fluorocarbon).

C. End housings
   1. Cast ASTM A48 Class 30 gray iron.

D. Shrouds and Covers
   1. Shrouds
      a. Glass bead blast and passivate AISI 316L stainless steel.
   2. Cover
      a. Manufacturing identification plate mounting on surface.
      b. Glass bead blast and passivate AISI 316L stainless steel.

E. Drum Baffle/ Channel Seal and Brush
   1. Drum Baffle
      a. Glass bead blast and passivate AISI 316L stainless steel.
   2. Channel Seal
      a. Buna-N rubber 60A durometer.
   3. Brush
      a. Nylon bristles with PVC base

F. Couplings
   1. Low Speed Coupling
      a. Two-piece 3-jaw interlocking design.
      b. Hardened AISI 4140 alloy steel
   2. High Speed Coupling
      a. Type L 3-jaw with elastomer
      b. Buna-N spider.

G. Lifting Brackets
   1. AISI 316 stainless steel.

H. Speed Reducer
1. Grease lubricated cycloidal design Cyclo Series 6000 with 377:1 reduction ratio.
2. Manufacturer: Sumitomo Machinery Corporation of America.

I. Motor
1. XPNV Immersible Explosion Proof Motor: Baldor Electric Company.
a. Installed Horsepower: 1 HP.
b. Motor Service Factor: 1.15.
c. Minimum Motor Efficiency (at Full Load): 85.5 percent.
d. Minimum Motor Power Factor (at Full Load): 80.
e. UL rated NEMA 6P, Class I, Div. 1 Groups C&D, Class II Div. 2, Groups F&G, Class III Div. 1.
f. Manufacturer rating of 40 consecutive days of submergence at a maximum depth of 40 feet.
g. Capable of operating in air 100 percent of time with no external cooling required.
h. No fan cooling during operation.
i. Utilize ceramic shaft seal requiring no oil lubrication.

2.5 SUPPORT AND INSTALLATION FRAME & LIFTING GUIDES

Frame and Guide Rails provides structure for mounting and positioning of the grinder in the integral open channel of the fiberglass manhole. Frame secures the grinder in position and provides structure and baffling to properly support and prevent unwanted bypass of material.

A. Support Frame
1. Support Frame
a. Support Frame slides into Channel Frame guide slots positioning Grinder and Solids Diverter into channel without further fastening or assembly.
b. Mechanism for adjustment of the grinder to set the distance of the cutter teeth to the perforated drum of the Solids Diverter.
c. Designs that do not allow for adjustment of cutter teeth to screen are not acceptable.
d. AISI 316L stainless steel with a passivated bead blast finish.

B. Channel Frame
1. Mounts to channel walls supporting weight of grinder with suitable anchors supplied by contractor for installation.
2. Frame guide plate to allow grinder to be lifted or lowered in and out of frame with no removal of fasteners.
3. Adjustable flanges allow frame to connect to manhole integral channel walls for sealing.

C. Guide Rail
1. Provides guidance of grinder into frame of manhole.
2. Mounted to manhole walls with suitable anchors.
3. Uses guide plate mounted to grinder to interface with guide slots in rail to guide grinder into installation frame.

D. Lifting Bail
1. Mounts to top cover of grinder and provides single pick point for lifting of grinder.
2. Eyebolt 1-1/4-inch ID
3. Working load Limit: 3500 lb

E. Material & Finish
   1. Fabricated of AISI 316L stainless steel.
   2. Finish: No special requirements

F. Lifting Chain
   1. Provides sling hook, shackle, and chain for lifting of grinder.
   2. Working load Limit: 3000 lb
   3. Material: AISI 316 stainless steel.

2.6 MOTOR CONTROLLER

A. DESIGN: NEMA 4X enclosure with programmable logic controller (PLC), operation and fail indicators, ~~and~~ selector switches, and pushbuttons.

B. Basis of Design:
   1. Model# PC2222 as manufactured and supplied by JWC Environmental Inc.
      a. Motor Controller Power Supply: 460 V/ 3 PH/ 60 Hz.
      b. Control and Monitoring Equipment Power Supply: 24VDC 5A

C. Enclosure, Selector Switches, Pushbuttons and Pilot Lights
   1. Enclosure NEMA 4X
      a. 316SS with hinged door and mounting flanges.
      b. Selector Switches: (2) 30 mm, three-position, rated equal or better than the enclosure and indicate On-Off/Reset-Remote for Grinder and Screen.
      c. Pilot Lights: 30 mm, LED (pilot lamp), rated equal or better than the enclosure and indicate POWER ON, GRINDER RUN, SCREEN RUN, and MOTOR FAULT.
      d. Red mushroom style Emergency Stop pushbutton and 30mm Black Reset Pushbutton.
      e. Inner door for mounting of pilot devices, selector switches and touchscreen. Thus outer door will be blank and not include windows, pilot devices or equipment.
      f. 316SS Sun shade and mounting hardware.
         1) A.E. Stainless Direct – SS-ESS-PBS1 Stainless Steel Sunshade made to fit dimensions of grinder control panel. Or approved equal.

D. Programmable Logic Controller
   1. Basis of Design: Allen Bradley Compact Logix 1769 Series
      a. 1769-L30ER Processor 2MB
      b. 1769-IQ16 16PT Discrete Input Module
      c. 1769-IF8 8PT Analog Input Module
      d. 1769-OW8I 8PT Analog Output Module (x2)
      e. 1769-PB2 PLC Rack Power Supply
      f. 1769-ECR End Cap Right
      g. Ethernet IP Provisions

E. Operator Interface Terminal
   1. Basis of Design: Allen Bradley Panelview 7
      a. 2711P-T6 Panelview Plus 7-6” Touchscreen
      b. Touch Operation, Color TFT LCD Screen
      c. 512MB memory
      d. Configuration Factory Talk Software

e. SD Card Slot
f. To be installed on the inner door of the panel

F. Motor Starters, Overload Relays and Control Power Transformer:
1. Starters
a. IEC, full voltage, and reversing.
b. Maximum short circuit protective fault current 100 kA.
2. Overload Relays
a. Adjustable and sized to full load amperes (FLA) of the motor.
3. Control Power Transformer
a. Produce 120-volt AC power from the supply power. Sized and fused in accordance with code to accommodate the control power requirements.

G. Current Transducers
1. 4-20mA analog output.

H. Operation:
1. Grinder Control: In accordance with ON-OFF/RESET-REMOTE Selector Switch.
a. OFF/RESET Position (OFF): De-energizes Grinder.
b. OFF/RESET Position (RESET): Clears all fault conditions.
c. ON Position: Energizes Grinder
2. REMOTE Position: Grinder operates as controlled by a remote start/stop dry contact.Solids Diverter Control: In accordance with ON-OFF-AUTO selector switch setting.
a. OFF Position: Solids Diverter will not run. Motor controller faults to be cleared with RESET pushbutton.
b. ON Position: Solids Diverter will run forward.
c. AUTO Position: Solids Diverter operates as controlled by Grinder operation.
3. Emergency Stop: In accordance EMERGENCY STOP pushbutton depressed:
a. Control circuit de-energizes the PLC outputs to all motor starters, causing the coils of all motors starters to be de-energized.
b. Fail relay energizes. OIT will display message: [Emergency Stop Activated].
c. Emergency Stop condition only cleared locally by resolving the issue, resetting the EMERGENCY STOP switch and depressing the RESET pushbutton.
4. No current sensed at Grinder motor running condition: Controller will activate FAIL indicator and OIT will display message: [Grinder Fail to Run].
5. No current sensed at Solids Diverter motor running condition: Controller will activate FAIL indicator and OIT will display message: [Solids Diverter Fail to Run].

6. Grinder JAM Condition: In accordance with setting of current transducer.
a. Controller will stop and reverse the Grinder motor three (3) times and activate the Grinder FAIL indicator and relay.
b. Grinder will stop operation.
7. Grinder MOTOR OVERLOAD Condition: In accordance with setting of Motor Overload Relay.
a. The MOTOR FAULT indicator lamp will be illuminated, and the FAIL contact will be closed.
b. Grinder will stop operation.
8. Grinder MOTOR OVERTEMP Condition: In accordance with setting of Motor Thermostat. (Only with applicable motors).
a. The MOTOR FAULT indicator lamp will be illuminated, and the FAIL contact

will be closed.

b. Grinder will stop operation.

9. Solids Diverter MOTOR OVERLOAD Condition: Motor will be de-energized.
   a. The FAULT indicator lamp will be illuminated, and the FAIL contact will be closed. OIT will display message: [Solids Diverter Motor Overload].
   b. Solids Diverter will stop operation.
   c. Grinder will continue to operate.
10. Solids Diverter MOTOR OVERTEMP Condition: Motor will be de-energized.
    a. The FAULT indicator lamp will be illuminated, and the FAIL contact will be closed. OIT will display message: [Solids Diverter Motor Overtemp.].
    b. Solids Diverter will stop operation.
    c. Grinder will continue to operate.
11. Power Failure:
    a. While System is Operating: System shall not return to normal operation until power is restored and START pushbutton is pressed.
    b. While System is in a Fail Condition: System shall return to a fail state when power is restored. The fail state shall not be cleared until reset.
12. Reset of Grinder and Solids Diverter: Accomplished from the controller only.
13. Remote monitoring and Control
    a. Provide dry contact outputs for the following signals: REMOTE position, grinder RUNNING status, Solids Diverter RUNNING status, and grinder FAIL status.
    b. Accept from a dry contact output from the remote control system a grinder REMOTE START command.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate installation of the equipment in accordance with the manufacturer’s installation instructions, approved submittals, and in accordance with OSHA, local, state, and federal codes, and regulations.

3.2 FIELD QUALITY CONTROL

A. INSPECTION
1. The manufacturer is required to provide the services of a factory or manufacturer’s representative for a minimum of one day to inspect the equipment for proper installation, apply power for the first time and check for proper motor rotation, oversee the initial introduction of material into the system and confirm the equipment operates as intended.

B. TRAINING
1. Field training for operations, maintenance, and supervisory staff members is to be provided by a manufacturer or manufacturer’s representative. Field instruction shall cover key components of the equipment, operating and maintenance requirements and troubleshooting techniques.

3.3 SPARE PARTS
1. Provide any recommended spare parts listed in the O&M manual to cover the first 12 months of operation.

END OF SECTION 462433