

TECHNICAL SPECIFICATIONS

**Sarasota County Public
Utilities Department**

1001 Sarasota Center Blvd.
Sarasota, FL 34240



Set No. _____

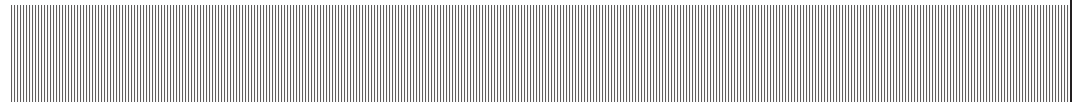
Technical Specifications

Sarasota County

**Home Depot Master Pump
Station and Force Main**

100% Specifications

December 2025



Prepared By:



ARCADIS U.S., Inc.

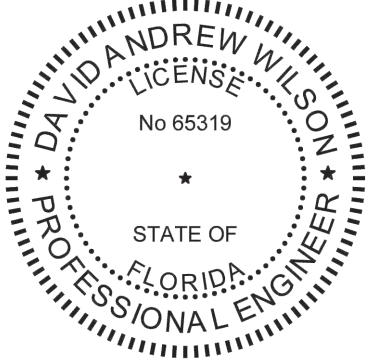
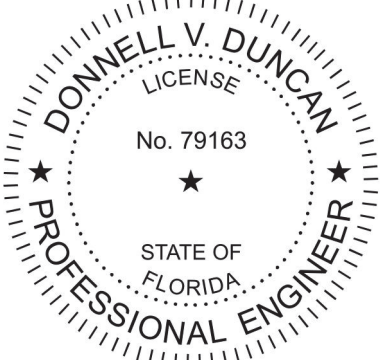
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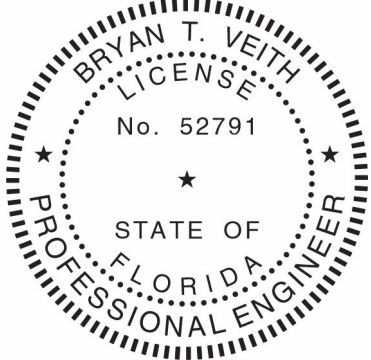
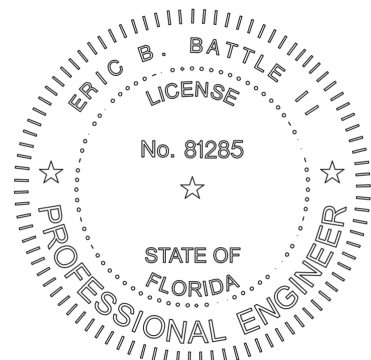
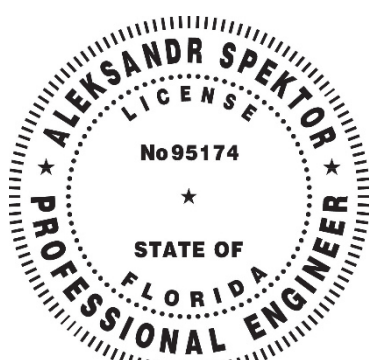
SARASOTA COUNTY
HOME DEPOT MASTER PUMP STATION AND FORCE MAIN

ENGINEER:

Arcadis - 1990 Main ST, Suite 750, Sarasota, FL. 34236

Veith Engineering – 2201 Cantu Ct., Suite 118, Sarasota, FL, 34232

DAVID WILSON, PE NO. 65319  Digitally signed by David A Wilson Date: 2025.12.29 13:42:25 -05'00' David A Wilson	The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual: • Division 01 • Division 02 • Division 31 • Division 32 • Division 33 • Division 40 – Sections 40 05 05, 40 05 19, 40 05 31, 40 05 33, 40 05 53, 40 05 86
DONNELL DUNCAN, PE NO. 59360  Digitally signed by Donnell Duncan DN: CN=Donnell Duncan, dnQualifier=A01410D00000198F10809500001436B, O=Unaffiliated, C=US Reason: I agree to specified portions of this document Date: 2025.12.30 00:21:04-05'00' Donnell Duncan	The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual: • Division 02 • Division 03 • Division 05 • Division 07 • Division 09 • Division 40 – 40 05 07

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It is a violation of applicable laws and regulations governing professional licensing and registration for any person, unless acting under the direction of the licensed and registered design professional(s) indicated above, to alter in any way the Specifications in this Project Manual.

Sarasota County Home Depot Master Pump Station & Force Main

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SECTION 01 11 13

SUMMARY OF WORK

PART 1 – GENERAL

1.1 SECTION INCLUDES- NOT USED

1.2 LOCATION AND DESCRIPTION OF WORK

The work is broken into two parts:

A. Force main

1. The force main work is located in Sarasota County, and extends from the Home Depot Master Pump Station proceeding east under I-75, north on Hawaii Drive, east on Bikini Road crossing Phillippi Creek Branch AA, and north on Maui Way to the intersection on Bee Ridge Road.
2. Another forcemain is located on Cattleman Road near Center Pointe Drive and will run from Cattleman Road into the Vortex Drop Manhole at the Home Depot Master Lift Station.
3. Work to be performed under this Contract includes, but is not limited to, constructing a sanitary sewer force main ranging in size from 12-inch diameter PVC and 16-inch diameter PVC to 18-inch diameter HDPE. Included, but not limited to, are air release valves, piping installed by open-cut and trenchless methods, and all other Work required in accordance with the Contract Documents.

B. Master Pump Station

1. The Work is located at the Home Depot Master Pump Station, at 4099 Cattlemen Road, Sarasota, FL 34233.
2. The Work to be performed under this Contract includes, but is not limited to, constructing the Work described below and all related appurtenances. The Work includes, but is not limited to, the following
 - a. General Conditions
 - 1) Mobilization and demobilization.
 - 2) Provisions of a complete project administration and management.
 - 3) Provisions for all applicable permits and inspections.
 - 4) Coordination, sequencing, and scheduling.
 - 5) Provisions for all bonding.
 - 6) Provisions for all construction facilities and temporary controls.
 - 7) Payment of all applicable fees associated with the Project.
 - 8) Provisions for all required shop drawings and submittals.
 - 9) Procurement and provisions for storage of all CONTRACTOR-supplied materials and equipment.
 - 10) Protection of existing facilities.
 - 11) Provisions for temporary lift and rigging equipment.

- 12) Provisions for temporary bypass pumping and temporary odor control.
 - 13) Attendance of meetings.
 - 14) Provisions for construction of staging area.
 - 15) Development of a Site-specific health and safety plan.
 - 16) Provision of all record documentation.
 - 17) Provision of all O&M manuals.
 - 18) Provision of all testing, start-ups, inspections, and training.
 - 19) Provision of an orderly Work closeout following Work acceptance by OWNER.
 - 20) Provision of Work guarantee and warranties.
- b. Demolition (Refer to Section 02 41 00)
- 1) Removal and disposal of existing odor control system in its entirety.
 - 2) Removal and disposal of existing generator in its entirety.
 - 3) Removal of above ground piping associated with the abandoned valve vault on the corner of Cattleman Rd and Center Pointe Drive, as well as the removal of the vault and associated piping within.
 - 4) Removal of all electrical components.
 - 5) Removal of water line and backflow preventer.
 - 6) Removal and disposal of existing fence in its entirety.
 - 7) Removal and disposal of manhole cone and cover.
 - 8) Removal and disposal of force main piping as shown on drawings.
- c. Cleaning
- 1) The OWNER will pump down the existing wet well. CONTRACTOR shall be responsible for removal of the residual wet well contents. Approximately 2 feet of wastewater, as measured upward from the wet well floor elevation, shall require removal by CONTRACTOR.
 - 2) CONTRACTOR shall be responsible for cleaning to remove debris and settled solids from existing wet well as required to complete the modifications, including floor fill concrete and bench work and repairs to the existing wet well interior liner system. The existing wet well is a confined space.
 - 3) CONTRACTOR shall be responsible for the handling, management, transport, and disposal of all settled solids debris removed from the existing wet well. Transportation and disposal shall be in accordance with all federal, state, and local regulations.
- d. Site/Civil Improvements
- 1) Proposed site perimeter fencing and gate.
 - 2) Proposed buried piping, fittings, valves, and appurtenances.
 - 3) Proposed underground electrical services upgrade.
 - 4) Temporary excavation support system, by-pass pumping, odor control, and dewatering, as required.
 - 5) Tree and stump removal, where called for.
 - 6) Clearing and grubbing.

- e. Structural Improvements
 - 1) Supply and installation of proposed cast-in-place concrete equipment housekeeping pads/foundations, as indicated on Drawings.
 - 2) Supply and installation of concrete pipe supports, as indicated on Drawings.
- f. Process/Mechanical Improvements
 - 1) Supply and installation of new impellers on existing pumps.
 - 2) Supply and installation of exposed piping, fittings, valves, supports, restraints, and appurtenances.
 - 3) Supply and installation of proposed coating systems, as specified or scheduled.
 - 4) Supply and installation of proposed odor control system.
 - 5) Supply and installation of proposed diesel back up pump.
 - 6) Testing, start-up, troubleshooting, and commissioning of proposed equipment and piping.
- g. Electrical Improvements
 - 1) Coordination with local utility for proposed electrical service secondary relocation.
 - 2) Supply and installation of new service entrance and distribution equipment
 - 3) Installation of equipment based on area classifications, including hazardous, wet, and corrosive areas.
 - 4) Supply and installation of new RVSS and ATL starter cabinets
 - 5) Wiring and connection of proposed process/mechanical equipment including, but not limited to, submersible pumps, diesel back-up pump, odor control system (by others), and liquid level, pressure, and flow sensing instrumentation.
 - 6) Installation, wiring, and connection of proposed pump station pump control panel, Mission RTU, and Network Interface Panel.
 - 7) Testing, start-up, troubleshooting, and commissioning of electrical distribution equipment as well as instrumentation and control circuits.
- h. Instrumentation Improvements
 - 1) Supply, installation, and integration of field instruments.
 - 2) Supply, installation and integration of new redundant level instruments and floats in the wet well.
 - 3) Supply and installation of PLC based control panel and network interface panel for integration with Owner's existing SCADA network.
 - 4) Supply of Mission RTU for integration with Diesel Engine Pump.
 - 5) Configuration of PLC, OIT and SCADA HMI for monitoring and controls of the pump station.
 - 6) Testing, start-up, troubleshooting and commissioning of field instruments, panels, and control components for proposed operation of the pump station.

C. Contracting Method: The Project shall be constructed under one prime Contract.

D. Hazardous Environmental Conditions:

1. To the best of Owner's knowledge, information and belief, the Site has been a sewage lift station since 1982. Prior to that time the site was undeveloped land.

1.3 OTHER CONSTRUCTION CONTRACTS (NOT USED)

1.4 WORK BY OTHERS

- A. Non-Professional Services Contracted by OWNER: OWNER will retain services of the following entities to perform the services indicated relative to the Project. CONTRACTOR shall coordinate and schedule the Work with, and cooperate with, the entities performing the following services for OWNER.

1. Odor Control System:

- a. OWNER has, or will, retain the services of Evoqua for all work related to the Odor Control system.

1.5 WORK BY OWNER (NOT USED)

1.6 OWNER FURNISHED EQUIPMENT AND MATERIALS (NOT USED)

1.7 ASSIGNED PROCUREMENT CONTRACTS (NOT USED)

1.8 SEQUENCE AND PROGRESS OF WORK

- A. Incorporate sequencing of the Work into the Progress Schedule

1.9 CONTRACTOR'S USE OF SITE

- A. CONTRACTOR's use of the Site shall be confined to the areas shown.
- B. Move stored materials and equipment that interfere with operations of OWNER, other contractors, and others performing work for OWNER.
- C. Site access shall be directed by the OWNER and ENGINEER.

1.10 EASEMENTS AND RIGHTS-OF-WAY

- A. General:
 1. Easements and rights-of-way required for the permanent improvements included in the Work will be provided by OWNER in accordance with the General Conditions.
 2. Confine construction operations within OWNER's property, public rights-of-way, easements obtained by OWNER, and limits shown, and property for which CONTRACTOR has made arrangements directly with property owner(s).
 3. Use care in placing construction tools, equipment, excavated materials, and materials and equipment to be incorporated into the Work to avoid damaging property and interfering with traffic.
 4. Do not enter private property outside the construction limits without permission from the owner of the property.

- B. On Private Property:

1. General limits of OWNER-furnished easements are shown on the Drawings.

1.11 NOTICES TO OWNERS AND AUTHORITIES OF PROPERTIES ADJACENT TO THE WORK

- A. Notify owners of adjacent property and utility owners when prosecution of the Work may affect their property, facilities, or use of property.
- B. When it is necessary to temporarily obstruct access to property, or when utility service connection will be interrupted, provide notices sufficiently in advance to enable affected persons to provide for their needs. Such notifications shall comply with Laws and Regulations and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.
- C. Notify utility owners and other concerned entities not less than 48 hours prior to cutting or closing streets or other traffic areas or excavating near Underground Facilities or exposed utilities.
- D. Contractor shall coordinate with the shopping plaza management to schedule and notify them of the planned work times, any damage to the driveway or parking lot surfaces outside the trench limits caused by the construct work shall be repaired at the contractor's expense. Coordination shall include written and email notice to Home Depot, My Poor Kitty, LLC d/b/a Madfish Grill NNN REIT, and Fitness International d/b/a L.A. Fitness 30 days before commencement of construction on all parcels and be provided with full contact information for a supervisor of the contractor and a County representative to be able to contact for any issues which arise until completion of construction. Those persons receiving notice for shall be the following:
 1. John_chescavage@homedepot.com
Home Depot U.S.A., Inc.
2455 Paces Ferry Road
Atlanta, GA 30339
 2. Trey_conway@homedepot.com
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 10. Kristin.furniss@nnnreit.com
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Orlando, FL 32801
 11. brian.smith@lowndes-law.com
Lowndes, Drosdick, Doster, Kantor & Reed, PA.
c/o Brian E. Smith, Esq.
215 North Eola Drive
Orlando, FL 32801
 12. Fitness International, LLC, a California limited liability
company, d/b/a LA Fitness and Pro Results
C/o Shutts & Bowen,S LLP
Attn: Fred Werdine, Esq.
4301 West Boy Scout Blvd., Suite 300, Tampa FL 33607
 13. My Poor Kitty, LLC, a Florida limited liability company
d/b/a Madfish Grill
C/o Ryan C. Reese, Esquire
Moore, Bowman, Reese. PA.
4100 W. Kennedy Blvd., #221, Tampa, FL 33609
 14. The Cutter Corporation of Sarasota, Inc., a Florida
corporation
C/o Milcs R. Milwee. Registered Agent
5955 Sheps Island Road. Sarasota, FL 34241-950

1.12 SALVAGE OF MATERIALS AND EQUIPMENT (NOT USED)

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 14 16

COORDINATION WITH OWNER'S OPERATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. This Section includes requirements for coordinating with OWNER's operations during the Project, and includes requirements for tie-ins and shutdowns necessary to complete the Work without impact on OWNER's operations except as allowed in this Section.
 - 2. CONTRACTOR shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to coordinate with OWNER's operations during the Work in accordance with this Section.
- B. Coordination:
 - 1. Review construction procedures under other Specifications sections and coordinate Work that will be performed with or before the Work specified in this Section.
- C. Related Sections:
 - 1. Section 01 11 13, Summary of Work.
 - 2. Section 01 51 41, Temporary Pumping.
 - 3. Section 01 57 05, Temporary Controls
- D. Except for shutdowns specified in this Section, perform the Work such that OWNER's facilities remain in continuous satisfactory operation during the Project. Schedule and conduct the Work such that the Work does not: impede OWNER's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products or effluent, cause odors or other nuisances, or affect the public health, safety, and convenience.
- E. Work not specifically covered in this Section or in referenced Sections may, in general, be completed, within the Contract Times, at any time during regular working hours in accordance with the Contract Documents, subject to the requirements in this Section.
- F. As a substitute to the procedures specified in this Section, CONTRACTOR may propose providing additional temporary facilities that can eliminate or mitigate a constraint without additional cost to OWNER, provided such additional temporary facilities: do not present hazards to the public, personnel, structures, and equipment; that such additional temporary facilities do not adversely affect OWNER's ability to comply with Laws and Regulations, permits, and operating requirements; that such temporary facilities do not generate or foster the generation of odors and other nuisances; and that requirements of the Contract Documents are fulfilled.

- G. Coordinate shutdowns with OWNER and ENGINEER. When possible, combine multiple tie-ins into a single shutdown to reduce impacts on OWNER's operations and processes.
- H. Operation of Existing Systems and Equipment during the Work:
 - 1. Do not shut off or disconnect existing operating systems or equipment, unless accepted by ENGINEER in writing.
 - 2. Operation of existing systems and equipment will be by OWNER unless otherwise specified or indicated.
 - 3. Where necessary for the Work, CONTRACTOR shall seal or bulkhead OWNER-operated gates and valves to prevent leakage that may affect the Work, OWNER's operations, or both.
 - 4. Provide temporary watertight plugs, bulkheads, and line stops as required. After completing the Work, remove seals, plugs, bulkhead, and line stops to satisfaction of ENGINEER.
- K. Requirements for temporary pumping are in Section 01 51 41, Temporary Pumping. Requirements for temporary pumping associated with specific shutdowns are indicated in this Section.

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Substitute Sequence Submittal: When deviation from specified sequence or procedures is proposed, furnish submittal explaining in detail the proposed sequence or procedures and associated effects, including evidence that OWNER's operations will not be adversely affected, to an extent greater than originally contemplated in the Contract Documents, by proposed substitution. List benefits of proposed substitution, including benefits to Progress Schedule. Submit in accordance with the General Conditions.
- B. Informational Submittals: Submit the following:
 - 1. Shutdown Planning Submittal:
 - a. For each shutdown, submit an inventory of labor, materials, and equipment required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for OWNER to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.
 - b. Furnish submittal to ENGINEER not less than 30 days prior to proposed shutdown start date. Do not start shutdown until obtaining ENGINEER's acceptance of shutdown planning submittal.
 - 2. Shutdown Notification: After ENGINEER's acceptance of shutdown planning submittal and prior to starting the shutdown, submit written notification to OWNER and ENGINEER of date and time each shutdown is to start. Submit notification not less than 120 hours in advance of each shutdown.

1.3 GENERAL CONSTRAINTS

- A. Indicated in the Contract Documents are the sequence and shutdown durations, where applicable, for OWNER'S equipment, systems, and conduits (including piping and ducting) that are to be taken out of service temporarily for the Work. New materials, equipment, and systems may be used by OWNER after the specified field quality controls and testing are successfully completed and the materials or equipment are Substantially Complete in accordance with the Contract Documents.
- B. The following constraints apply to coordination with OWNER's operations:
 - 1. Operational Access: OWNER'S personnel shall have access to equipment and areas of the facility that remain in operation.
 - 2. Schedule and perform equipment and system start-ups for Monday through Thursday. Equipment and systems shall not be placed into operation on Friday, Saturday, and Sunday without prior approval of OWNER, unless specifically indicated otherwise in the Contract Documents.
 - 3. Dead End Valves or Conduits: Provide blind flanges, watertight bulkheads, or valve at temporary and permanent terminuses of conduits, including piping and ducting. Blind flanges and bulkheads shall be suitable for the service and braced and blocked, as required, or otherwise restrained as directed by ENGINEER. Temporary valves shall be suitable for their associated service. Where valve is provided at permanent terminus of conduit, including piping or ducting, also provide on downstream side of valve a blind flange with drain/flushing connection.
 - 4. OWNER will assist CONTRACTOR in dewatering process tanks, basins, conduits, and other work areas to be dewatered for shutdowns. Maintain clean and dry work area by pumping and properly disposing of fluid and other material that accumulates in work areas.
 - 5. Draining and Cleaning of Conduits, Tanks, and Basins:
 - a. Unless otherwise shown or indicated, CONTRACTOR shall dewater process tanks, basins, conduits (including piping) at beginning of each shutdown. Flush, wash down, and clean tanks, basins, conduits (including piping), and other work areas.
 - b. CONTRACTOR shall remove liquids and solids and dispose of them at appropriate location at the Site as directed by ENGINEER. Unless otherwise specified or indicated, contents of tanks, basins, and conduits (including piping) undergoing modifications shall be transferred to existing process tanks or conduits at the Site with capacity sufficient to accept such discharges, using hoses, temporary piping, temporary pumps, or other means provided by CONTRACTOR. Discharge of fluids across floors is not allowed.
 - c. If drainage point is not available on the conduit (including piping) to be drained, provide a wet tap using tapping saddle and valve or other method approved by ENGINEER. Uncontrolled spillage of contents of conduits (including piping) is not allowed.
 - d. Spillage shall be brought to ENGINEER's attention immediately, both verbally and in writing, and reported in accordance with Laws and Regulations. CONTRACTOR shall wash down spillage to floor drains or sumps or other appropriate location and flush the system to prevent clogging and odors. If spillage is not suitable for

discharge to the drainage system, such as chemical spills, as determined by ENGINEER, CONTRACTOR shall remove spillage by other method, such as vactor truck, sorbents, or other method acceptable to ENGINEER.

1.4 SEQUENCE OF WORK

- A. CONTRACTOR is to submit the sequence of operation to be approved by the COUNTY and CONSULTANT. CONSULTANT will review the Maintenance of Plant Operations (MOPO) submitted and provide feedback for the CONTRACTOR.

1.6 SHUTDOWNS

A. General:

1. Terminology: A "shutdown" is when a portion of the normal operation of OWNER's facility, whether equipment, systems, conduit (including piping and ducting), has to be temporarily suspended or taken out of service to perform the Work.
2. Work that may interrupt normal operations shall be accomplished at times convenient to OWNER unless otherwise indicated in the Contract Documents.
3. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, materials, equipment, spare parts, both temporary and permanent, necessary to successfully perform the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to commencing the associated shutdown. Demonstrate to ENGINEER's satisfaction that CONTRACTOR has complied with such requirements before commencing the shutdown.
4. If CONTRACTOR's operations cause an unscheduled interruption of OWNER's operations, immediately re-establish satisfactory operation for OWNER.
5. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of OWNER's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by CONTRACTOR if, in ENGINEER's opinion, CONTRACTOR did not comply with requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in performing the Work and complying with applicable permits, Laws, and Regulations.
6. Shutdowns shall be in accordance with Table 01 14 16-B of this Section. Work requiring service interruptions for tie-ins shall be performed during scheduled shutdowns.
7. Temporary, short-term shutdowns of smaller conduits (including piping and ducting), equipment, and systems may not be included in Table 01 14 16-B. Coordinate requirements for such shutdowns with ENGINEER and OWNER. Where necessary, obtain ENGINEER's interpretation or clarification before proceeding.

B. Shutdowns of Electrical Systems:

1. Comply with Laws and Regulations, including the National Electric Code.

2. CONTRACTOR shall lock out and tag circuit breakers and switches operated by OWNER and shall verify that affected cables and wires are de-energized to ground potential before shutdown Work is started.
3. Upon completion of shutdown Work, remove the locks and tags and notify ENGINEER that facilities are available for use.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL

- A. In addition to requirements of this Section, comply with Section 01 51 41, Temporary Pumping, Section 01 57 05, Temporary Controls and other Contract Documents applicable to Work associated with shutdowns, tie-ins, temporary pumping (where applicable), and similar work.

3.2 DETAILED SHUTDOWN REQUIREMENTS

- A. Shutdown A:
 1. General:
 - a. Affected Equipment Operating Prior to Shutdown: Submersible Pumps 1, 2, 3, and Odor Control System.
 - b. Equipment Operating During Shutdown: In accordance with Table 01 14 16-B of this Section.
 - c. Equipment Out of Service During Shutdown: In accordance with Table 01 14 16-B of this Section.
 - d. Impact on Other Equipment and Processes: No impact on other equipment since everything will be on bypass pumping and bypass odor control.
 - e. Procedure: CONTRACTOR to submit sequence of construction to be approved by CONSULTANT and COUNTY.
 - f. Dates: Shutdown shall be accomplished between times to be coordinated with the COUNTY
 - g. Time: Shutdown shall be performed at a time convenient to the COUNTY.
 2. Temporary Pumping: Provide temporary pumping system, including controls, as follows:
 - a. Purpose: To convey incoming wastewater around the Master Pump Station so the station can be taken off line.
 - b. System Capacity: 1711 gallons per minute.
 - c. Fluid Pumped: Wastewater
 - d. Controls: Provide a complete control system to ensure the manhole
 - e. Suction Location: Dependent on CONTRACTORs proposal for sequence of construction.
 - f. Discharge Location: Dependent on CONTRACTORs proposal for sequence of construction.
 - h. Flow Meter: Not Required for temporary pumping.
 3. Prior to Shutdown:

- a. Obtain ENGINEER's acceptance of proposed shutdown planning submittal and shutdown notification submittal.
- b. Bring necessary piping, couplings, valves, equipment, and appurtenances to the work areas.
- c. Assist OWNER in preparing to take equipment, tanks, basins, and conduits (including piping and ducting) temporarily out of service.
- d. Coordinate other tie-ins to be performed simultaneously.
- e. Install, check, and test the temporary pumping system.
- 4. Following Shutdown:
 - a. Verify functionality of equipment and systems.
 - b. Verify operation of new equipment and systems, and verify that joints in conduits (including piping and ducting) are watertight or gastight as applicable.
 - c. Repair joints that are not watertight or gastight, as applicable.
 - d. Remove temporary pumping system and appurtenances.

3.3 SCHEDULES

- A. The schedules indicated below, attached following this Section's "End of Section" designation, are part of this Specifications Section:
 - 1. Table 01 14 16-A, Schedule of Tie-ins.
 - 2. Table 01 14 16-B, Schedule of Shutdowns.

+ + END OF SECTION + +

TABLE 01 14 16-A SCHEDULE OF TIE-INS					
Tie-In No.	New Line Size and Service	Existing (Connecting) Line Size & Service	Tie-In Building/Location	Construction Stage	Remarks
1					
2					
3					
4					
5					
6					

TABLE 01 14 16-B SCHEDULE OF SHUTDOWNS				
Shut-down No.	Process Equipment and Service Lines Out-of-Service During Shutdown	Process Equipment In Operation During Shutdown	Tie-In Nos.	Maximum Duration
A	Submersible Pumps 1, 2, 3, Odor Control System, and Diesel Generator	Back up pumps and back up odor control		TBD
B				
C				
D				

SECTION 01 22 13

MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.1 SUMMARY

A. Scope:

1. Items listed starting in Article 1.4 of this Section refer to and are the same pay items listed in the Pricing Table and constitute all pay items for completing the Work. No direct or separate payment will be made for providing miscellaneous temporary or accessory works, plant or facility services, CONTRACTOR'S or ENGINEER'S field offices, layout surveys, Project signs, sanitary requirements, testing, safety provisions and safety devices, submittals and record drawings, water supplies, power and fuel, maintenance of traffic, removal of waste, security, coordination with OWNER'S operations, information technology (including hardware, software, and services) required during construction, commissioning where specified, bonds, insurance, or other requirements of the General Conditions, Division 01 Specifications, and other requirements of the Contract Documents. Compensation for all services, items, materials, and equipment shall be included in prices stipulated for lump sum and unit price pay items listed in this Section and included in the Contract.

1.2 ENGINEER'S ESTIMATE OF QUANTITIES

- A. ENGINEER's estimated quantities for items of Work, as included in the Contract, are approximate only and are included solely for purpose of comparing Bids and pricing. OWNER does not expressly or by implication agree that nature of materials encountered below the ground surface or actual quantities of material encountered or required will correspond with the quantities included in the Contract at the time of award and reserves right to increase or decrease quantities or to eliminate quantities as OWNER may deem necessary.

1.3 RELATED PROVISIONS

- A. Payments to CONTRACTOR: Refer to General Conditions and Agreement
- B. Changes in Contract Price: Refer to General Conditions
- C. Schedule of Values: Refer to Section 01 29 73, Schedule of Values.

1.4 BID ITEMS

Item 1.

Mobilization/Demobilization: Payment for mobilization and demobilization shall be made at the contract lump sum price for mobilization and demobilization. The lump sum dollar value listed on the Pricing Table for this Bid Item shall not exceed five (5%) percent of the subtotal of Bid Item Nos. 2 through 11. This price shall be full compensation for all costs incurred for preparatory work and operations including, but not limited to those necessary for the movement of

personnel, equipment, supplies, construction signs, and incidentals to the project site; for the establishment of the field offices and other facilities necessary for work on the project; fees for bonds and insurance; and for all other work and operations including submittals, which must be performed prior to beginning work on the various items. Payment for mobilization will be payable in the first partial payment at 75% of the contract lump sum price for mobilization and demobilization, and the balance of 25% of the contract lump sum price will be payable in the final project close-out payment upon demobilization.

Item 2.

Demolition: Payment for the complete Demolition work shall be made at the contract lump sum price for this Bid Item. The lump sum price shall include the demolition, cleanup, removal, and disposal of existing equipment and materials, to the limits indicated on the Drawings, and as specified herein.

Item 3.

Pump Station General Construction: Payment for the complete Pump Station General Construction work shall be made at the contract lump sum price for this Bid Item. This Bid Item includes furnishing, installing, testing, and commissioning water and wastewater process piping, fittings, and valves associated with the Home Depot Master Pump Station; replacement of existing impellers with new impellers, labor, testing, and startup of pumps; furnishing, installing, testing, and commissioning all piping, fittings, supports, and guide rails for conditioning pump; all work associated with the installation of two vortex drops in the manhole specified in the drawings as well as all structural work associated with the pump station including but not limited to: concrete slab and hatches, security fence and gates, and manhole cone replacement; Furnishing, installing, testing, and commissioning of a diesel back up pump; rehabilitation of manhole being used for the vortex drops; civil work associated with earthwork and erosion control; site restoration including removal of unsuitable materials, backfill, select fill material, grading and sodding, and all other Work not specifically included under the other items.

Item 4.

Temporary Bypass Pumping and Odor Control: Payment for the complete Temporary Bypass Pumping and Odor Control work shall be made at the contract lump sum price for this Bid Item. This Bid Item includes the cost of temporary bypass pumping as well as temporary odor control.

Item 5.

Electrical, Instrumentation & Controls Construction: Payment for the complete Electrical, Instrumentation & Controls Construction work shall be made at the contract lump sum price for this Bid Item. The lump sum bid price shall include construction and installation of all electrical and I&C equipment such as but not limited to site lighting, horn/strobe alarm, conduit runs, fittings, cables, and wiring, pull and junction boxes, raceways, control panel, and field instrumentation. This will also include testing, start-up, troubleshooting and commissioning of field instruments, panels, and control components for operation of the pump station.

Item 6.

C900 PVC Force Main (16-inch) DR 18: Payment for Item 6 will be full compensation for completing the Work associated with C900 PVC Force Main (16-inch) DR 18, as shown and specified. The unit price bid shall be on a linear foot (LF) basis, and shall include all, supervision, labor, materials, tools,

equipment and services for the completion of all work associated with the C900 PVC Force Main (16-inch) DR 18.

Item 7.

HDPE Force Main (18-inch) DR 11-HDD: Payment for Item 6 will be full compensation for completing the Work associated with HDPE Force Main (18-inch) DR 11-HDD, as shown and specified. The unit price bid shall be on a linear foot (LF) basis, and shall include all, supervision, labor, materials, tools, equipment and services for the completion of all work associated with the HDPE Force Main (18-inch) DR 11-HDD.

Item 8.

Force Main General Construction: Payment for the complete Force Main General Construction work shall be made at the contract lump sum price for this Bid Item. This Bid Item includes furnishing, installing, testing, and commissioning valves associated with the Force Main; maintenance of traffic; jack and bore operations; pavement restoration; clearing and grubbing; civil work associated with earthwork and erosion control; site restoration including removal of unsuitable materials, backfill, select fill material, grading and sodding, and all other Work not specifically included under the other items.

Item 9.

Open Cut Across Home Depot Driveway and Parking Lot:

1. Measurement:

- a. This bid item covers the excavation, installation, backfilling, temporary surface restoration, and final restoration associated with the open-cut crossing of the driveway and parking lot at the shopping plaza. The work will involve trenching to install the specified pipeline or utility infrastructure and shall be conducted with minimal disruption to the shopping plaza operations.
- b. All work related to the driveway crossing must be performed during nighttime hours on weekends (Saturday and Sunday nights) to minimize traffic and business disruptions. The work site is to be secured and traffic control measures to be installed per contract requirements. The affected driveway and parking lots are to be operable for safe pedestrian and vehicular traffic by the next morning at 7:00 A. M. local time. Temporary steel plates or other approved temporary surface materials shall be used to cover all trenches and make the work area accessible.
- c. Final restoration of the driveway and parking lot, including curbing, paving, markings, and landscaping, is to be completed as soon as practical after the pipeline and utility installation is finished. The final restoration is to match the existing driveways, curbing, pavement, and surface conditions, including material type and thickness, or as specified in the contract documents.
- d. Contractor shall coordinate with the shopping plaza management to schedule and notify them of the planned work times. Any damage to the driveway or parking lot surfaces outside the trench limits caused by the construction work shall be repaired at the contractor's expense.
- e. Payment will be made to the Contractor based on actual invoiced amounts paid by the Contractor to FP&L for services associated with both coordinating the isolation of, as well as connecting and disconnecting service conductors within the pad-mounted utility transformer and any additional FP&L fees.

2. Payment:

- a. This bid item will be paid for on a lump sum basis, which shall include all labor, materials, equipment, traffic control, temporary and final surface restoration, and all other incidental items necessary to complete the open cut across the driveway and parking lot in accordance with the contract specifications.

Item 10.

Temporary Phillippi Creek Crossing

1. Measurement: This bid item covers the design, permitting, materials, and all necessary appurtenances for construction, installation, filling, and surface restoration, associated with the temporary access to the west side of the Phillippi Creek from the east. Contractor shall include in the price shop drawings with a design signed and sealed by a licensed Florida PE.
2. Payment: This bid item will be paid for on a lump sum basis, which shall include all labor, design, permitting, materials, and all necessary appurtenances for construction, installation, filling, and surface restoration, and all other incidental items necessary to complete associated with the temporary access to the west side of the Phillippi Creek from the east in accordance with the contract specifications.

Item 11.

C-900 PVC Force Main (12-inch) DR 14: Payment for Item 11 will be full compensation for completing the Work associated with PVC Force Main (12-inch) DR 14, as shown and specified. The unit price bid shall be on a linear foot (LF) basis, and shall include all, supervision, labor, materials, tools, equipment and services for the completion of all work associated with the PVC Force Main (12-inch) DR 14.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION++

SECTION 01 29 73

SCHEDULE OF VALUES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall prepare and submit to ENGINEER for acceptance a Schedule of Values that allocates cost to each item of the Work. Schedule of Value list of line items shall correspond to each aspect of the Work, establishing in detail the portion of the Contract Price allocated to each major component of the Work.
2. Upon request of ENGINEER, support values with data that substantiates their correctness.
3. Submit preliminary Schedule of Values to ENGINEER for initial review. CONTRACTOR shall incorporate ENGINEER's comments into the Schedule of Values and resubmit to ENGINEER. ENGINEER may require corrections and re-submittals until Schedule of Values is acceptable.
4. Schedule of Values may be used as a basis for negotiating price of changes, if any, in the Work.
5. Schedule of Values and the Progress Schedule updates specified in Section 01 32 16, Progress Schedule, will be basis for preparing each Application for Payment.
6. This Section specifies the general Schedule of Values requirements.

1.2 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Submit to ENGINEER Schedule of Values in the form and quantity required in Section 01 33 00, Submittal Procedures.
2. Content of Schedule of Values submittals shall be in accordance with Article 1.3 of this Section.
3. Timing of Submittals:
 - a. Submit preliminary Schedule of Values within time limit indicated in the Contract Documents.
 - b. Submittal of the Schedule of Values for acceptance by ENGINEER shall be in accordance with these Contract Documents. Applications for Payment will not be accepted without an approved Schedule of Values.
 - c. When required by ENGINEER, promptly submit updated Schedule of Values to include cost breakdowns for changes in the Contract Price.

1.3 SCHEDULE OF VALUES FORMAT AND CONTENT

A. Organization and Major Elements of Schedule of Values

1. Prepare Schedule of Values in a manner that aligns with presentation of the Application for Payment form.
2. Organization in Accordance with Specification Sections:
 - a. Organize the Schedule of Values by the various Specifications Section numbers and titles included in the Contract Documents.

- b. Label each row in the Schedule of Values with the appropriate Specifications Section number. Include an amount for each row in the Schedule of Values.
 - c. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
 - 3. Include in Schedule of Values unit price payment items with their associated quantity. Provide in the Schedule of Values detailed breakdown of unit prices when required by ENGINEER.
- B. Requirements for preliminary Schedule of Values and Schedule of Values are:
 - 1. Subcontracted Work:
 - a. Schedule of Values shall show division of Work between CONTRACTOR and Subcontractors.
 - b. Line items for Work to be done by Subcontractor shall include the word, "(SUBCONTRACTED)".
 - 2. Apportionment between Materials and Equipment, and Installation:
 - a. Schedule of Values shall include breakdown of costs for materials and equipment, installation, and other costs used in preparing the Bid by CONTRACTOR and each Subcontractor.
 - b. List purchase and delivery costs for materials and equipment for which CONTRACTOR may apply for payment as stored materials.
 - 3. Sum of individual values shown on the Schedule of Values shall equal the total of associated payment item. Sum of payment item totals in the Schedule of Values shall equal the Contract Price.
 - 4. Overhead and Profit: Include in each line item a directly proportional amount of CONTRACTOR's overhead and profit. Do not include overhead and profit as separate item(s).
 - 5. Include separate line item for each allowance, and for each unit price item.
 - 6. Bonds and Insurance Costs: Include line item for bonds and insurance.
 - 7. Include relevant items for the Standard General Conditions, permits (when applicable), construction Progress Schedule, and other items required by ENGINEER. Include such items in Applications for Payment on payment schedule acceptable to ENGINEER.
 - 8. Line items for construction photographic documentation; temporary utilities and temporary facilities, field offices, temporary controls, field engineering, and similar Work shall be included in the Schedule of Values and proportioned in Applications for Payment throughout duration of the Work.
 - 9. Mobilization and Demobilization:
 - a. Include separate line items under each appropriate payment item for mobilization and demobilization. Document for ENGINEER the activities included in mobilization and demobilization line items.
 - b. Refer to Section 01 22 13, Measurement and Payment, for Mobilization and Demobilization payment procedures.
 - 10. Include separate line item for costs for Shop Drawings, samples, and other submittals; operations and maintenance manuals; field testing; and training of operations and maintenance personnel.
 - 11. Include in the Schedule of Values a line item with appropriate value for Project record documents.
 - 12. Coordinate Schedule of Values with Section 01 32 16, Progress Schedule.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

Home Depot MPS and FM
 Schedule of Values
 30036073

01 29 73-2

+ + END OF SECTION + +

SECTION 01 31 13

PROJECT COORDINATION

PART 1 – GENERAL

1.1 DESCRIPTION

- A. CONTRACTOR shall coordinate the Work, including testing agencies whether hired by CONTRACTOR, OWNER, or others; Subcontractors, Suppliers, and others with whom coordination is necessary, in accordance with the General Conditions and this Section, to perform the Work within the Contract Times and in accordance with the Contract Documents.
- B. In accordance with the General Conditions CONTRACTOR shall cooperate with and coordinate the Work with other contractors, utility owners, utility service companies, OWNER's and facility manager's employees working at the Site, and other entities working at the Site, in accordance with Section 01 11 13, Summary of Work.
- C. CONTRACTOR will not be responsible or liable for damage unless damage is through negligence of CONTRACTOR, or Subcontractors, Supplier, or other entity employed by CONTRACTOR.
- D. Attend and participate in all project coordination and progress meetings, and report on the progress of the Work and compliance with the Progress Schedule.
- E. Maintain sufficient competent personnel, drafting and computer-aided drafting/design (CADD) equipment, software, systems, and supplies at the Site for preparing layout drawings, coordination drawings, and record documents. With the Contract Documents and Shop Drawings, use such coordination drawings as tools for coordinating the Work of various trades. Where such coordination drawings are to be prepared by mechanical, electrical, plumbing, or heating-ventilating-air conditioning Subcontractors and other Subcontractors, ensure that each Subcontractor maintains required personnel and facilities at the Site.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 31 19

PRE-CONSTRUCTION CONFERENCE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. A pre-construction conference will be held for the Project.
 - 2. CONTRACTOR shall attend the conference prepared to discuss all items on the pre-construction conference agenda.
 - 3. ENGINEER will distribute an agenda, preside at conference, and prepare and distribute minutes to all conference participants and others as requested.
- B. Purpose of Pre-construction Conference:
 - 1. Purpose of conference is to designate responsible personnel, establish working relationships, discuss preliminary schedules submitted by CONTRACTOR, and review administrative and procedural requirements for the Project.
 - 2. Matters requiring coordination will be discussed and procedures for handling such matters will be established.
 - 3. Unless otherwise indicated in the Contract Documents or otherwise agreed to by the entities involved, Site mobilization meeting will be part of the pre-construction conference.

1.2 PREPARATION FOR PRE-CONSTRUCTION CONFERENCE

- A. Date, Time, and Location:
 - 1. Conference will be held after execution of the Contract and before Work starts at the Site.
 - 2. ENGINEER will establish the date, time, and location of conference and notify the interested and involved entities.
- B. Submittals Required Prior to Pre-construction Conference:
 - 1. Not less than three days prior to pre-construction conference, submit the following preliminary schedules in accordance with the General Conditions and other requirements of the Contract Documents:
 - a. Preliminary Progress Schedule.
 - b. Preliminary Schedule of Submittals.
 - c. Preliminary Schedule of Values.
 - d. Listing of identity and general scope of Work or supply (as applicable) of planned Subcontractors and Suppliers. Indicate extent of each Subcontract proposed and overall percentage of Contract Price to be subcontracted.
- C. CONTRACTOR shall furnish information required and contribute appropriate items for discussion at the pre-construction conference.
- D. Handouts for Pre-Construction Conference:

1. CONTRACTOR shall bring to the conference the following, with sufficient number of copies for each attendee:
 - a. Preliminary Progress Schedule, as submitted to ENGINEER.
 - b. Preliminary Schedule of Submittals, as submitted to ENGINEER.
 - c. Preliminary Schedule of Values, as submitted to ENGINEER.
 - d. Listing of identity and general scope of Work or supply of planned Subcontractors and Suppliers.
 - e. List of emergency contact information, in accordance with Article 1.5 of this section

1.3 REQUIRED ATTENDEES

- A. Representative of each entity attending the conference shall be authorized to act on that entity's behalf.
- B. Contractor Attendance: Conference shall be attended by CONTRACTOR's:
 1. Project manager.
 2. Site superintendent
 3. Project managers for major Subcontractors, and major equipment Suppliers as CONTRACTOR deems appropriate.
- C. Other attendees will be representatives of:
 1. OWNER, if available
 2. ENGINEER.
 3. Authorities having jurisdiction over the Work, if available.
 4. Utility owners, as applicable.
 5. Others as requested by OWNER, CONTRACTOR, or ENGINEER.

1.4 AGENDA

- A. Preliminary Agenda: Be prepared to discuss in detail the topics indicated below. Revisions, if any, to the agenda below will be furnished to required attendees prior to the pre-construction conference.
 1. Procedural and Administrative:
 - a. Personnel and Teams:
 - 1) Designation of roles and personnel.
 - 2) Limitations of authority of personnel, including personnel who will sign Contract modifications and make binding decisions.
 - 3) Subcontractors and Suppliers in attendance.
 - 4) Authorities having jurisdiction.
 - b. Procedures for communications and correspondence, including electronic communication protocols.
 - c. Copies of the Contract Documents and availability.
 - d. Subcontractors and Suppliers.
 - 1) Lists of proposed Subcontractors and Suppliers.
 - e. The Work and Scheduling:
 - 1) General scope of the Work.
 - 2) Contract Times, including Milestones (if any).
 - 3) Phasing and sequencing.
 - 4) Preliminary Progress Schedule.
 - 5) Critical path activities.
 - f. Safety:
 - 1) Responsibility for safety.

- 2) Contractor's safety representative.
 - 3) Emergency procedures and accident reporting.
 - 4) Emergency contact information.
 - 5) Confined space entry permits.
 - 6) Hazardous materials communication program.
 - 7) Impact of Project on public safety.
- g. Permits.
- h. Review of insurance requirements and insurance claims.
- i. Coordination:
 - 1) Project coordination, and coordination among contractors.
 - 2) Coordination with Owner's operations.
 - 3) Progress meetings.
- j. Products and Submittals:
 - 1) Preliminary Schedule of Submittals.
 - 2) Submittal procedures.
 - 3) Contractor coordination and approval stamp.
 - 4) Meaning of Engineer's actions/submittal disposition.
 - 5) Construction photographic documentation.
- k. Substitutes and "Or-Equals":
 - 1) Product options.
 - 2) Procedures for proposing "or-equals".
 - 3) Procedures for proposing substitutes.
- l. Contract Modification Procedures
 - 1) Requests for interpretation
 - 2) Written clarifications
 - 3) Field Orders
 - 4) Proposal Requests
 - 5) Change Proposals
 - 6) Work Change Directives.
 - 7) Change Orders.
 - 8) Procedure for Claims and dispute resolution
- m. Payment:
 - 1) Owner's Project financing and funding, as applicable.
 - 2) Owner's tax-exempt status.
 - 3) Preliminary Schedule of Values
 - 4) Procedures for measuring for payment.
 - 5) Retainage.
 - 6) Progress payment procedures.
 - 7) Prevailing wage rates and payrolls.
- n. Testing and inspections, including notification requirements.
- o. Disposal of demolition materials.
- p. Record documents.
- q. Preliminary Discussion of Contract Closeout:
 - 1) Procedures for Substantial Completion.
 - 2) Contract closeout requirements.
 - 3) Correction period.
 - 4) Duration of bonds and insurance.
- 2. Site Mobilization (if not covered in a separate meeting):
 - a. Working hours and overtime.
 - b. Field offices, storage trailers, and staging areas.
 - c. Temporary facilities.
 - d. Temporary utilities and limitations on utility consumption (where applicable).

- e. Utility company coordination (if not done as a separate meeting).
- f. Access to Site, access roads, and parking for construction vehicles.
- g. Maintenance and protection of traffic.
- h. Use of Site and premises.
- i. Protection of property.
- j. Security.
- k. Temporary controls, such as sediment and erosion controls, noise controls, dust control, storm water controls, and other such measures.
- l. Site barriers and temporary fencing.
- m. Storage of materials and equipment.
- n. Reference points and benchmarks; surveys and layouts.
- o. Site maintenance during the Project.
- p. Cleaning and removal of trash and debris.
- q. Restoration.
- 3. General discussion and questions.
- 4. Next meeting.
- 5. Site visit, if required.

1.5 EMERGENCY CONTACT INFORMATION

- A. CONTRACTOR shall provide list of emergency contact information for 24-hour use throughout the Project. Emergency contact information shall be updated and kept current throughout the Project. If personnel or contact information change, provide updated emergency contact information list at the next progress meeting.
- B. CONTRACTOR's list of emergency contact information shall include:
 - 1. CONTRACTOR's project manager's office, field office, and cellular numbers.
 - 2. CONTRACTOR's Site superintendent's office, field office, and cellular numbers.
 - 3. CONTRACTOR's foreman's field office, and cellular numbers.
 - 4. Major Subcontractors' and Suppliers' office, and cellular numbers of project manager and foreman (when applicable).
- C. Additional Emergency Contact Information:
 - 1. OWNER's office and cellular telephone numbers.
 - 2. OWNER's central 24-hour emergency telephone number, if applicable.
 - 3. ENGINEER's project manager's office and cellular telephone numbers.
 - 4. Resident Project Representative's office, field office, and cellular telephone numbers for each RPR.
 - 5. Utility companies' 24-hour contact telephone number(s), including gas, water, sewer, oil, telephone, cable television/telecommunications, and other companies or concerns having utilities in the vicinity of the Work.
 - 6. Highway and street owners' 24-hour telephone number(s).
 - 7. Emergency telephone numbers, including: "Emergency: Dial 911", and seven-digit telephone numbers for the hospital, ambulance, police, and fire department nearest to the Site. Provide names of each of these institutions.
 - 8. Other involved entities as applicable.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 31 20

PROGRESS MEETINGS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Progress meetings will be held throughout the Project. CONTRACTOR shall attend each progress meeting prepared to discuss in detail all items on the agenda.
 - 2. ENGINEER will preside at progress meetings and will prepare and distribute minutes of progress meetings to all meeting participants and others as requested.

1.2 PREPARATION FOR PROGRESS MEETINGS

- A. Date and Time:
 - 1. Regular Meetings: Every month on a day and time agreeable to OWNER, ENGINEER, and CONTRACTOR.
 - 2. Other Meetings: As required.
- B. Location:
 - 1. CONTRACTOR's field office at the Site or other location mutually agreed upon by OWNER, CONTRACTOR, and ENGINEER.
- C. Handouts:
 - 1. CONTRACTOR shall bring to each progress meeting not less than four copies of each of the following:
 - a. List of Work accomplished since the previous progress meeting.
 - b. Up-to-date Progress Schedule.
 - c. Up-to-date Schedule of Submittals.
 - d. Detailed "look-ahead" schedule of Work planned through the next progress meeting, with specific starting and ending dates for each activity, including shutdowns, deliveries of important materials and equipment, Milestones (if any), and important activities affecting the OWNER, Project, and Site.
 - e. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.

1.3 REQUIRED ATTENDANCE

- A. Representatives present for each entity shall be authorized to act on that entity's behalf.
- B. Required Attendees:
 - 1. CONTRACTOR:

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- a. Project manager.
- b. Site superintendent.
- c. Safety representative.
- d. When needed for the discussion of a particular agenda item, representatives of Subcontractors and Suppliers shall attend meetings.
2. Construction coordinator (if any).
3. ENGINEER:
 - a. Project manager or designated representative
 - b. Resident Project Representative (if any).
 - c. Others as required by ENGINEER.
4. OWNER's representative(s), as required.
5. Testing and inspection entities, as required.
6. Others, as appropriate.

1.4 AGENDA

- A. Preliminary Agenda: Be prepared to discuss in detail the topics listed below. Revised agenda, if any, will be furnished to CONTRACTOR prior to first progress meeting. Progress meeting agenda may be modified by ENGINEER during the Project as required.
 1. Review, comment, and amendment (if required) of minutes of previous progress meeting.
 2. Review of progress since the previous progress meeting.
 3. Planned progress through next progress meeting.
 4. Review of Progress Schedule
 - a. Contract Times, including Milestones (if any)
 - b. Critical path.
 - c. Schedules for fabrication and delivery of materials and equipment.
 - d. Corrective measures, if required.
 5. Submittals:
 - a. Review status of critical submittals.
 - b. Review revisions to Schedule of Submittals.
 6. Contract Modifications
 - a. Requests for interpretation
 - b. Written clarifications
 - c. Field Orders
 - d. Proposal Requests
 - e. Change Proposals
 - f. Work Change Directives.
 - g. Change Orders.
 - h. Claims.
 7. Applications for progress payments.
 8. Problems, conflicts, and observations.
 9. Quality standards, testing, and inspections.
 10. Coordination between parties.
 11. Site management issues, including access, security, maintenance and protection of traffic, maintenance, cleaning, and other Site issues.
 12. Safety.
 13. Permits.
 14. Construction photographic documentation.
 15. Record documents status.
 16. Punch list status, as applicable.

17. Other business.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++END OF SECTION++

SECTION 01 32 16

PROGRESS SCHEDULE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall prepare and submit Progress Schedules and related documents in accordance with the General Conditions and this Section, unless otherwise accepted by ENGINEER.
2. Maintain and update Progress Schedules and related documents.
3. Progress Schedule shall be resource-loaded CPM Progress Schedule.
4. ENGINEER's acceptance of the Progress Schedule or related documents, and comments or opinions concerning activities in the Progress Schedule and related documents shall not control CONTRACTOR's independent judgment concerning means, methods, techniques, sequences, and procedures of construction, unless the associated means, method, technique, sequence, or procedure is directed by the Contract Documents. CONTRACTOR is solely responsible for complying with the Contract Times.

B. Use of Float:

1. Float belongs to the Project and may be used by OWNER or CONTRACTOR to accommodate changes in the Work, or to mitigate the effect of events that delay performance or compliance with the Contract Times.
2. Changes or delays that influence Activities that have float and that do not extend the Critical Path are not justification for an extension of the Contract Times.

C. Factors Affecting the Progress Schedule:

1. In preparing the Progress Schedule, take into consideration submittal requirements and submittal review times, time for fabricating and delivering materials and equipment, source quality control (including shop testing) and field quality control (including testing at the Site), Subcontractors' work, availability and abilities of workers, availability of construction equipment, weather conditions, restrictions in operations at the Site and coordination with OWNER's operations, and other factors that have the potential to affect completion of the Work within the Contract Times.
2. Comply with sequencing requirements indicated in the following:
 - a. Section 01 11 13, Summary of Work.

1.2 DEFINITIONS

A. The following terms are defined for this Section and supplement the terms defined in the General Conditions:

1. Activity: An element of the construction work that has the following specific characteristics: consumes time, consumes resources, has a definable start and finish, is assignable, and is measurable.
2. Constraint: An imposed date on the Progress Schedule or an imposed time between Activities. The Contract Times are Constraints.

3. CPM Progress Schedule: Computerized Progress Schedule in Critical Path Method (CPM) format which accounts for the entire Work, defines the interrelationships between elements of the Work, reflects the uncompleted Work, and indicates the sequence with which the Work has been completed, indicates the sequence in which uncompleted Work will be completed, and indicates the duration of each Activity.
4. Critical Path: The continuous chain of Activities with the longest duration for completion within the Contract Times.
5. Early Start: The earliest possible date an Activity can start according to the assigned relationships among Activities.
6. Early Finish: The earliest date an Activity can finish according to the assigned relationships among the Activities.
7. Late Finish: The latest date an Activity can finish without extending the Contract Times.
8. Late Start: The latest date an Activity can start without extending the Contract Times.
9. Float: The time difference between the calculated duration of the Activity chain and the Critical Path.
10. Total Float: The total number of days that an Activity (or chain of Activities) can be delayed without affecting the Contract Times.
11. Network Diagram: A time-scaled logic diagram depicting the durations and relationships of the Activities.
12. Work Areas, Area, or System: A logical breakdown of the Project elements or a group of Activities which, when collectively assembled, are readily identifiable on the Project (for example: yard piping, a structure or building, a treatment process, or other logical grouping).

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Progress Schedule Preparer:
 - a. CONTRACTOR shall retain services of a scheduling consultant or shall self-prepare and maintain the Progress Schedule using a qualified employee with experience in scheduling, and experienced with the scheduling software required for the Project, and experience serving as Progress Schedule preparer on construction projects of similar type, size, and scope to this Project.
 - b. Progress Schedule preparer shall have not less than five years experience using the schedule software required on construction projects of similar type, size, and scope as the Project.
 - c. Prior to engaging a scheduling consultant or using a qualified employee, submit to ENGINEER the following:
 - 1) Name and address of proposed Progress Schedule preparer and the names of personnel who will be assigned to scheduling the Project.
 - 2) Information sufficient to demonstrate that proposed Progress Schedule preparer and scheduling personnel to be assigned to the Project possess qualifications complying with this Section. For each person assigned, submit list of similar type, size, contract value of projects, names and contact information of engineer or architect and owner.
 - d. Engineer's Review of Qualifications:
 - 1) ENGINEER will respond to CONTRACTOR whether proposed

scheduling personnel are acceptable within 14 days after ENGINEER's receipt of complete qualifications.

2) If qualifications are not acceptable, submit qualifications of acceptable personnel within 14 days of receipt of ENGINEER's non-acceptance.

3) ENGINEER's acceptance or non-acceptance of qualifications does not release CONTRACTOR from its obligations under the Contract Documents.

B. Scheduling Workshop Conferences:

1. Prior to preparing the preliminary Progress Schedule, CONTRACTOR shall meet with ENGINEER for 1 workshop conference, up to 4 hours in duration, to review technical requirements and Progress Schedule development methods and procedures.
2. Required Attendance:
 - a. CONTRACTOR's project manager, site superintendent, and Progress Schedule preparer.
 - b. ENGINEER
 - c. OWNER may attend one or more scheduling workshop conferences.
3. ENGINEER will prepare minutes of the scheduling workshop conferences and distribute minutes to each attendee.

1.4 SUBMITTALS

A. Quantity of each submittal required and timing of submittals are in this Section.

B. Informational Submittals: Submit the following:

1. Initial Progress Schedules:
 - a. Preliminary Progress Schedule with associated Network Diagrams, narrative report.
 - b. Acceptable Progress Schedule with associated Network Diagrams, narrative report.
 - c. Preliminary resource-loaded Progress Schedule and associated reports.
 - d. Acceptable resource-loaded Progress Schedule and associated reports.
 - e. Submit each Progress Schedule submittal with letter of transmittal complying with requirements of Section 01 33 00, Submittal Procedures.
2. Progress Schedule Updates.
 - a. Progress Schedule updates shall comply with requirements of this Section, and shall include updated Progress Schedule, narrative report, updated Network Diagram when relationships among Activities are changed, and updated mathematical tabulations.
 - b. Submit updated Progress Schedule prior to each progress meeting. When a Progress Schedule remains unchanged from one progress meeting to the next, submit a written statement to that effect. In addition to monthly Progress Schedule submittals, also bring to progress meeting the number of printed copies of the updated Progress Schedule indicated in Section 01 31 20, Progress Meetings.
3. Look-Ahead Schedules
 - a. Furnish 30-day look-ahead schedule at each progress meeting.
4. Time Impact Analyses: Submit in accordance with this Section.

5. Recovery Schedule: Submit in accordance with this Section.
6. Qualifications:
 - a. Submit qualifications of Progress Schedule preparer, and other personnel that will assist Progress Schedule preparer in preparing and maintaining the Progress Schedule.

1.5 INITIAL PROGRESS SCHEDULES

- A. Type and Organization of Progress Schedules:
 1. Prepare Progress Schedule using Primavera P6 software, unless other scheduling software is acceptable to ENGINEER.
 2. Sheet Size: 22 inches by 34 inches unless otherwise accepted by ENGINEER.
 3. Time Scale: Indicate first date of each work week.
 4. Activity Designations: Indicate title and related Specifications Section number.
 5. Progress Schedules shall be CPM Progress Schedules.
 6. Organization:
 - a. Indicate on the separate Schedule of Submittals dates for submitting and reviewing Shop Drawings, Samples, and other submittals.
 - b. Group deliveries of materials and equipment into a separate sub-schedule that is part of the Progress Schedule.
 - c. Group construction into Work Area sub-schedules (that are part of the Progress Schedule) by Activity.
 - d. Clearly indicate the Critical Path on the Progress Schedule.
 - e. Organize each Work Area sub-schedule by Specifications Section number.
- B. Preliminary Progress Schedule:
 1. Within 30 days after the Contract Times commence running, CONTRACTOR shall submit to ENGINEER the preliminary Progress Schedule covering the entire Project, with associated Network Diagrams.
 2. Submit four printed copies of preliminary Progress Schedule and associated reports and schedule-related documents to accompany the preliminary Progress Schedule, in accordance with the Submittals Article of this Section. Submit in accordance with Section 01 33 00, Submittal Procedures.
 3. ENGINEER will conduct a timely review of the preliminary Progress Schedule.
 4. Preliminary Progress Schedule shall comply with the Contract Documents relative to Progress Schedules, but need not be resource-loaded.
- C. Initial Acceptance of Progress Schedule:
 1. Not more than 45 days after the Contract Times commence running, a scheduling conference attended by CONTRACTOR, Progress Schedule preparer, ENGINEER, and others as appropriate will be held at the Site to review for acceptability to ENGINEER the preliminary Progress Schedule and associated Network Diagram and other reports and schedule-related documents required. Following the scheduling conference, CONTRACTOR shall have 15 days to make corrections and adjustments and to complete and resubmit the Progress Schedule and associated Network Diagram. Other than bonds and insurance, mobilization, and approved Shop Drawings (and acceptance of other submittals, as applicable) required for fabricating or purchasing materials and equipment to be incorporated into

the Work, no progress payment will be made to CONTRACTOR until acceptable Progress Schedule, Network Diagram, and other reports and schedule-related documents required are submitted to ENGINEER.

2. Submit four copies each of acceptable Progress Schedule with Network Diagram, reports, and other schedule-related documents required to accompany the initial acceptable Progress Schedule, in accordance with the Submittals Article of this Section. Submit in accordance with Section 01 33 00, Submittal Procedures.
3. The Progress Schedule will be acceptable to ENGINEER if it provides an orderly progression of the Work to completion within the Contract Times, in accordance with the Contract Documents. Such acceptance will not impose on ENGINEER responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve CONTRACTOR from CONTRACTOR's full responsibility therefor.
4. Initially-accepted Progress Schedule shall be identified as the baseline Progress Schedule.

1.6 PROGRESS SCHEDULE UPDATES

A. Updates:

1. Update the Progress Schedule not less-often than once per month. If during progress of the Work events develop that necessitate changes in the initially accepted Progress Schedule (e.g., baseline Progress Schedule), identify updated Progress Schedules sequentially as "Progress Schedule Revision 1, 2, 3, and continuing in sequence as required. Number the Progress Schedule submittals in accordance with Section 01 33 00, Submittal Procedures.
2. CONTRACTOR's Progress Schedule update shall include a narrative report in accordance with this Section. Narrative report shall include description of current progress and status of each Area of the Project, a description of progress for the period, a description of the Critical Path, a discussion of current or potential delays, Change Orders (pending and approved in since the previous Progress Schedule update), and other problems associated with maintaining the Work on schedule.
3. The update to the Progress Schedule shall be based on retained logic. Progress override logic is not allowed.
4. Required scheduling software, and schedule organization, format, and content for updated Progress Schedules are identical to that required in this Section for initial Progress Schedules.
5. Submit to ENGINEER four printed copies of the updated Progress Schedule, Network Diagrams, narrative report, and other schedule-related reports and documents required, and two compact discs (CD) each with a complete software backup copy of the updated Progress Schedule.
6. Submit updated Network Diagrams when revisions are proposed to the logic. Indicate in the narrative report delays that have occurred since the previous updated Progress Schedule. ENGINEER will not recommend payment by OWNER of progress payments until updated Progress Schedule is received, reviewed, and accepted by ENGINEER. Payment for out-of-sequence Work is not allowed.

B. Monthly Schedule Meeting:

1. During the month, utilizing the previous month's four week look-ahead schedule. CONTRACTOR shall record the percent complete, start and finish

dates of each scheduled Activity with the remaining duration for each Activity started but not completed, including Activities associated with procurement of materials and equipment.

2. On the same day each month, not less than one week prior to a progress meeting, CONTRACTOR, Progress Schedule preparer, ENGINEER, and others as appropriate shall meet at the Site and tour the Work to review and update the schedule and progress information gathered by CONTRACTOR during the month. After acceptance of CONTRACTOR's updated data, Progress Schedule preparer shall use this information to update the Progress Schedule.

1.7 TIME IMPACT ANALYSIS

A. Evaluation by Engineer and Acceptance:

1. ENGINEER's evaluation of each time impact analysis comprised of complete information will be completed in timely manner after ENGINEER's receipt. Changes in the Contract Times will be made only by Change Order.
2. When mutual agreement is reached between the parties on effect of the change or delay in the Project, incorporate into the next Progress Schedule update the associated fragnets illustrating the influence of changes and delays.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide submittals in accordance with the General Conditions and this Section.
2. Provide submittals well in advance of need for the material or equipment, or procedure (as applicable), in the Work and with ample time required for delivery of material or equipment and to implement procedures following ENGINEER's approval or acceptance of the associated submittal. Work covered by a submittal will not be included in progress payments until approval or acceptance of related submittals has been obtained in accordance with the Contract Documents.
3. CONTRACTOR is responsible for dimensions to be confirmed and corrected at the Site, for information pertaining solely to the fabrication processes and to techniques of construction, and for coordinating the work of all trades. CONTRACTOR's signature of submittal's stamp and letter of transmittal shall be CONTRACTOR's representation that CONTRACTOR has met his obligations under the Contract Documents relative to that submittal.

B. Samples:

1. Conform submittal of Samples to the General Conditions and the Specification Section in which the Sample is specified.
2. Furnish at the same time Samples and submittals that are related to the same unit of Work or Specification Section. ENGINEER will not review submittals without associated Samples, and will not review Samples without associated submittals.
3. Samples shall clearly illustrate functional characteristics of product, all related parts and attachments, and full range of color, texture, pattern, and material.

1.2 TYPES OF SUBMITTALS

- ###### A. Submittal types are classified as follows: 1) Action Submittals, 2) Informational Submittals, 3) Closeout Submittals, and 4) Maintenance Material submittals. Type of each required submittal is designated in the respective Specification Sections; when type of submittal is not specified in the associated Specification Section, submittal will be classified as follows:

1. Action Submittals include:
 - a. Shop Drawings.
 - b. Product data.
 - c. Delegated design submittals, which include documents prepared, sealed, and signed by a design professional retained by CONTRACTOR, Subcontractor, or Supplier for materials and equipment to be incorporated into the completed Work. Delegated design submittals do not include submittals related to temporary

construction unless specified otherwise in the related Specification Section. Delegated design submittals include: design drawings, design data including calculations, specifications, certifications, and other submittals prepared by such design professional.

- d. Samples.
- e. Testing plans, procedures, and testing limitations.
- 2. Informational Submittals include:
 - a. Certificates.
 - b. Design data not sealed and signed by a design professional retained by CONTRACTOR, Subcontractor, or Supplier.
 - c. Pre-construction test and evaluation reports, such as reports on pilot testing, subsurface investigations, potential Hazardous Environmental Condition, and similar reports.
 - d. Supplier instructions, including installation data, and instructions for handling, starting-up, and troubleshooting.
 - e. Source quality control submittals (other than testing plans, procedures, and testing limitations), including results of shop testing.
 - f. Field or Site quality control submittals (other than testing plans, procedures, and testing limitations), including results of operating and acceptability tests at the Site.
 - g. Supplier reports.
 - h. Sustainable design submittals (other than sustainable design closeout documentation).
 - i. Special procedure submittals, including health and safety plans and other procedural submittals.
 - j. Qualifications statements.
- 3. Closeout Submittals include:
 - a. Maintenance contracts.
 - b. Operations and maintenance data.
 - c. Bonds, such as maintenance bonds and bonds for a specific product or system.
 - d. Warranty documentation.
 - e. Record documentation.
 - f. Sustainable design closeout documentation.
 - g. Software.
- 4. Maintenance Material Submittals include:
 - a. Spare parts.
 - b. Extra stock materials.
 - c. Tools.
- 5. When type of submittal is not specified and is not included in the list above, ENGINEER will determine the type of submittal.

B. Not Included in this Section: Administrative and procedural requirements for following are covered elsewhere in the Contract Documents:

- 1. Requests for interpretations of the Contract Documents.
- 2. Change Orders, Work Change Directives, and Field Orders.
- 3. Applications for Payment
- 4. Progress Schedules.
- 5. Photographic documentation.
- 6. Reports and documentation required in accordance with applicable permits
- 7. Site survey data.

1.3 SUBMITTALS REQUIRED IN THIS SECTION

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01 33 00-2

- A. Informational Submittals: Provide the following:
1. Schedule of Submittals:
 - a. Timing:
 - 1) Provide submittal within time frames specified in the Contract Documents.
 - 2) Provide updated Schedule of Submittals with each submittal of the updated Progress Schedule.
 - b. Content: In accordance with the General Conditions and this Section. Requirements for content of preliminary Schedule of Submittals and subsequent submittals of the Schedule of Submittals are identical. Identify on Schedule of Submittals all submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Indicate submittals that are on the Project's critical path. Indicate the following for each submittal:
 - 1) Date by which submittal will be provided to ENGINEER.
 - 2) Whether submittal will be for a substitution or "equal". Procedures for substitutions and "or equals" are specified in the General Conditions and the Division 01 Specifications.
 - 3) Date by which ENGINEER's response is required. At least 14 days shall be allowed from ENGINEER's receipt of each submittal. Allow increased time for large or complex submittals.
 - 4) For submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of other contractors.
 - c. Prepare Schedule of Submittals using same software, and in same format, specified for Progress Schedules.
 - d. Coordinate Schedule of Submittals with the Progress Schedule.
 - e. Schedule of Submittals that is not compatible with the Progress Schedule, or that does not indicate submittals on the Project's critical path, or that that places extraordinary demands on ENGINEER for time and resources, is unacceptable. Do not include submittals not required by the Contract Documents.
 - f. In preparing Schedule of Submittals:
 - 1) Considering the nature and complexity of each submittal, allow sufficient time for review and revision.
 - 2) Reasonable time shall be allowed for: ENGINEER's review and processing of submittals, for submittals to be revised and resubmitted, and for returning submittals to CONTRACTOR.
 - 3) Identify and accordingly schedule submittals that are expected to have long anticipated review times.

1.4 PROCEDURE FOR SUBMITTALS

- A. Submittal Identification System: Use the following submittal identification system, consisting of submittal number and review cycle number.
1. Submittal Number: Shall be separate and unique number correlating to each individual submittal required. CONTRACTOR shall assign submittal number as follows:
 - a. First part of submittal number shall be the applicable Specification Section number, followed by a hyphen.

- b. Second part of submittal number shall be a three-digit number (sequentially numbered from 001 through 999) assigned to each separate and unique submittal provided under the associated Specification Section.
 - c. Typical submittal number for the third submittal provided for Section 40 05 19, Ductile Iron Process Pipe, would be "40 05 19-003".
 2. Review Cycle Number: Shall be a letter designation indicating the initial submittal or re-submittal associated with each submittal number:
 - a. "A" = Initial (first) submittal.
 - b. "B" = Second submittal (e.g., first re-submittal).
 - c. "C" = Third submittal (e.g., second re-submittal).
 3. Examples:

Example Description	Submittal Identification	
	Submittal No.	Review Cycle
Initial (first) review cycle of the third submittal provided under Section 40 05 19, Ductile Iron Process Pipe	40 05 19-003-	A
Second review cycle (first re-submittal) of third submittal provided under Section 40 05 19, Ductile Iron Process Pipe	40 05 19-003-	B

- B. Letter of Transmittal for Submittals:
 1. Provide separate letter of transmittal with each submittal. Each submittal shall be for one Specification Section.
 2. At beginning of each letter of transmittal, provide a reference heading indicating: CONTRACTOR's name, OWNER's name, Project name, Contract name and number, transmittal number, and submittal number.
 3. For submittals with proposed deviations from requirements of the Contract Documents, letter of transmittal shall specifically describe each proposed variation.
- C. Contractor's Review and Stamp:
 1. Contractor's Review: Before transmitting submittals to ENGINEER, review submittals to:
 - a. assure proper coordination of the Work;
 - b. determine that each submittal is in accordance with CONTRACTOR's desires;
 - c. verify that submittal contains sufficient information for ENGINEER to determine compliance with the Contract Documents.
 2. Incomplete or inadequate submittals will be returned without review.
 3. Contractor's Stamp and Signature:
 - a. Each submittal provided shall bear CONTRACTOR's stamp of approval and signature, as evidence that submittal has been reviewed by CONTRACTOR and verified as complete and in accordance with the Contract Documents.
 - b. Submittals without CONTRACTOR's stamp and signature will be returned without review. Signatures that appear to be computer-generated will be regarded as unsigned and the associated submittal will be returned without review.
 - c. CONTRACTOR's stamp shall contain the following:

"Project Name: _____

Contractor's Name: _____

Date: _____

----- *Reference* -----

Item/Submittal Title: _____

Specifications:

Section: _____

Page No.: _____

Paragraph No.: _____

Drawing No.: _____ of _____

Location of Work: _____

Submittal No. and Review Cycle: _____

Coordinated by Contractor with Submittal Nos.: _____

I hereby certify that the Contractor has satisfied Contractor's obligations under the Contract Documents relative to Contractor's review and approval of this submittal.

Approved By (for Contractor): _____"

D. Submittal Marking and Organization:

1. Mark on each page of submittal and each individual component submitted with submittal number and applicable Specification paragraph.
2. Arrange submittal information in same order as requirements are written in the associated Specification Section.
3. Each Shop Drawing sheet shall have title block with complete identifying information satisfactory to ENGINEER.
4. Package together submittals for the same Specification Section. Do not provide required information piecemeal.

E. Format of Submittal and Recipients:

1. Action Submittals and Informational Submittals: Furnish in accordance with Table 01 33 00-A, except that submittals of Samples shall be as specified elsewhere in this Section:

**TABLE 01 33 00-A: SUBMITTAL CONTACTS
AND REQUIRED COPIES**

	Address for Deliveries	Contact Person	E-mail Address	No. of Hard-copies*	Remarks
a.	Engineer: ARCADIS-US, Inc. 4300 W Cypress Street, Suite 450, Tampa, FL 33607	Alex Spektor	Alex.Spektor@arcadis.com	One	One Electronic Version (PDF)
b.	Sarasota County Utilities 1001 Sarasota Center Blvd, Sarasota, FL 34240	Jeremy Parker	Jparker@scgov.net	Two	One Electronic Version (PDF)

**Hard copies are required for final approved submittals only. Interim submittals for review can be submitted electronically.*

2. Samples:
 - a. Securely label or tag Samples with submittal identification number. Label or tag shall include clear space at least three inches by three inches in size for affixing ENGINEER's review stamp. Label or tag shall not cover, conceal, or alter appearance or features of Sample. Label or tag shall not be separated from the Sample.
 - b. Submit number of Samples required in Specifications. If number of Samples is not specified in the associated Specification Section, provide at least three identical Samples of each item required for ENGINEER's approval. Samples will not be returned to CONTRACTOR. If CONTRACTOR requires Sample(s) for CONTRACTOR's use, notify ENGINEER in writing and provide additional Sample(s). CONTRACTOR is responsible for furnishing, shipping, and transporting additional Samples.
 - c. Deliver one Sample to ENGINEER's field office at the Site. Deliver balance of Samples to ENGINEER at address listed in Table 01 33 00-A, unless otherwise directed by ENGINEER.
3. Closeout Submittals:
 - a. Provide the following Closeout Submittals in accordance with Table 01 33 00-A: maintenance contracts; bonds for specific products or systems; warranty documentation; and sustainable design closeout documentation. On documents such as maintenance contracts and bonds, include on each document furnished original signature of entity issuing the document.
 - b. Operations and Maintenance Data: Submit in accordance with Section 01 78 23, Operations and Maintenance Data.
 - c. Record Documentation: Submit in accordance with Section 01 78 39, Project Record Documentation.
 - d. Software: Submit number of copies required in Specification Section where the software is specified. If number of copies is not specified, provide two copies on compact disc in addition to software loaded on to OWNER's computer(s) or microprocessor(s).
4. Maintenance Material Submittals: For spare parts, extra stock materials, and tools, submit quantity of items specified in associated Specification Section. Furnish in accordance with Section 01 78 43, Spare Parts and Extra Materials.

- F. Distribution:
1. Distribution of Hardcopies: ENGINEER will distribute each reviewed submittal requiring ENGINEER's written response as follows:
 - a. CONTRACTOR: two copies (except closeout submittals and maintenance material submittals).
 - b. Resident Project Representative: One copy (except closeout submittals and maintenance material submittals).
 - c. ENGINEER's File: Two hard copies and one electronic version.
- G. Resubmittals: Refer to the General Conditions for requirements regarding resubmitting required submittals.

1.5 ENGINEER'S REVIEW

- A. Timing: ENGINEER's review will conform to timing accepted by ENGINEER in the accepted Schedule of Submittals.
- B. Submittals not required in the Contract Documents will not be reviewed by ENGINEER and will not be recorded in ENGINEER's submittal log. All hardcopies of such submittals will be returned to CONTRACTOR.
- C. Action Submittals, Results of ENGINEER's Review: Each submittal will be given one of the following dispositions:
1. Approved: Upon return of submittal marked "Approved", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents.
 2. Approved as Corrected: Upon return of submittal marked "Approved as Corrected", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents, provided it is in accordance with corrections indicated.
 3. Approved as Corrected – Resubmit: Upon return of submittal marked "Approved as Corrected – Resubmit", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents, provided it is in accordance with corrections indicated. Provide to ENGINEER record re-submittal with all corrections made. Receipt of corrected re-submittal is required before materials or equipment covered in the submittal will be eligible for payment.
 4. Revise and Resubmit: Upon return of submittal marked "Revise and Resubmit", make the corrections indicated and re-submit to ENGINEER for approval.
 5. Not Approved: This disposition indicates material or equipment that cannot be approved. Upon return of submittal marked "Not Approved", repeat initial submittal procedure utilizing approvable material or equipment.
- D. Informational Submittals, Results of ENGINEER's Review:
1. Each submittal will be given one of the following dispositions:

- a. Accepted: Information included in submittal conforms to the applicable requirements of the Contract Documents, and is acceptable. No further action by CONTRACTOR is required relative to this submittal, and the Work covered by the submittal may proceed, and products with submittals with this disposition may be shipped or operated, as applicable.
 - b. Not Accepted: Submittal does not conform to applicable requirements of the Contract Documents and is not acceptable. Revise submittal and re-submit to indicate acceptability and conformance with the Contract Documents.
- E. Closeout Submittals, Results of ENGINEER's Review: Dispositions and meanings are the same as specified for Informational Submittals. When acceptable, Closeout Submittals will not receive a written response from ENGINEER. Disposition as "accepted" will be recorded in ENGINEER's submittal log. When Closeout Submittal is not acceptable, ENGINEER will provide written response to CONTRACTOR.
- F. Maintenance Material Submittals, Results of ENGINEER's Review: Dispositions and meanings are the same as specified for Informational Submittals. When acceptable, Maintenance Material Submittals will not receive a written response from ENGINEER. Disposition as "accepted" will be recorded in ENGINEER's submittal log. When Maintenance Material Submittal is not acceptable, ENGINEER will provide written response to CONTRACTOR, and CONTRACTOR is responsible for costs associated with transporting and handling of maintenance materials until compliance with the Contract Documents is achieved.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 45 29

TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall employ and pay for services of independent testing laboratory to perform specified services.
 - 2. Inspection, sampling, and testing shall be as specified in the Specifications including but not limited to:
 - a. Section 03 00 05, Concrete.
 - b. Other tests in the Contract Documents that are not specifically assigned to others.
 - 3. CONTRACTOR shall pay for:
 - a. Tests not specifically indicated in the Contract Documents as being OWNER's responsibility.
 - b. Tests made for CONTRACTOR's convenience.
 - c. Repeat tests required because of CONTRACTOR's negligence or defective Work, and retesting after failure of test for the same item to comply with the Contract Documents.
 - 4. Testing laboratory is not authorized to approve or accept any portion of the Work or defective Work; rescind, alter, or augment requirements of Contract Documents; and perform duties of CONTRACTOR.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
 - 2. ISO/IEC 17025, General Requirements for the Competence of Testing and Calibration Laboratories.
 - 3. NIST SRM, Standard Reference Materials.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Testing Laboratory:
 - a. Comply with applicable requirements of ASTM E329.
 - b. Testing laboratory shall be licensed to operate in the same state as the Site. Where applicable, laboratory shall be certified by the authority having jurisdiction for the types of testing required.
 - c. Testing equipment used by laboratory shall be calibrated at maximum intervals of twelve months by devices of accuracy traceable to one of the following: NIST SRM, ISO/IEC 17025, certified by state or local bureau of weights and measures, or values of natural physical constants generally accepted in the engineering and scientific community.

1.4 SUBMITTALS

- A. Informational Submittals: Submit the following:
 - 1. Quality Control Submittals and Test Reports: Testing laboratory shall promptly submit to CONTRACTOR results of testing and inspections, including:
 - a. Date issued.
 - b. Project title, number, and name of the Site.
 - c. Testing laboratory name and address.
 - d. Name and signature of inspector or person obtaining samples.
 - e. Date of inspection or sampling.
 - f. Record of temperature and weather.
 - g. Date of test.
 - h. Identification of material or product tested, and associated Specification Section.
 - i. Location in the Project.
 - j. Type of inspection or test.
 - k. Results of tests and observations regarding compliance with the Contract Documents.
 - 2. Qualifications Statements:
 - a. Testing Laboratory:
 - 1) Qualifications statement indicating experience and facilities for tests required under the Contract Documents.
 - 2) Copy of report of inspection of facilities during most recent NIST inspection tour. Include memorandum of remedies of deficiencies reported during inspection.
 - 3) Copy of certificate of calibration for each instrument or measuring device proposed for use, by accredited calibration agency.

1.5 TESTING LABORATORY DUTIES

- A. Testing laboratory shall:
 - 1. Cooperate with CONTRACTOR and provide qualified personnel promptly on notice.
 - 2. Perform required inspections, sampling, and testing of materials and methods of construction; comply with applicable reference standards and the Contract Documents; and ascertain compliance with requirements of the Contract Documents.
 - 3. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies in the Work that are observed during performance of services.
 - 4. Promptly submit to CONTRACTOR copies of reports of inspections and tests.
 - 5. Perform additional tests and services, as required by CONTRACTOR.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. CONTRACTOR shall:
 - 1. Cooperate with testing laboratory personnel.
 - 2. Provide to testing laboratory preliminary representative samples of materials and products to be tested, in required quantities.

Home Depot MPS and FM
Testing Laboratory Services
Furnished by Contractor
30036073

3. Promptly submit to ENGINEER copies of results of tests and inspections received from testing laboratory.
4. Provide to laboratory the preliminary design mix proposed for concrete and other material mixes to be tested by testing laboratory.
5. Provide labor and facilities:
 - a. For access to the Work to be tested, and where required, to Suppliers' operations.
 - b. For obtaining and handling samples at the Site.
 - c. For facilitating inspections and tests.
 - d. For testing laboratory's exclusive use for storing and curing of test samples.
 - e. Forms for preparing concrete test beams and cylinders.
6. Notify laboratory and ENGINEER sufficiently in advance of operations to allow assignment of personnel and scheduling of tests.
7. Arrange with laboratory and pay for additional services, sampling, and testing required for CONTRACTOR's convenience.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION +

SECTION 01 51 05

TEMPORARY UTILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. CONTRACTOR shall provide all temporary utilities required for the Project.
 - 1. Make all arrangements with utility service companies for temporary services and obtain required permits and approvals for temporary utilities.
 - 2. Pay all utility service costs, including cost of electricity, water, fuel, and other utility services required for the Work.
 - 3. Continuously maintain adequate utilities for all purposes during the Project, until removal of temporary utilities and temporary facilities. At minimum, provide and maintain temporary utilities through Substantial Completion and removal of temporary field offices and sheds.
 - 4. Should OWNER occupy part of the Project prior to Substantial Completion of the entire Work, cost of utilities consumed via temporary utilities serving the portion occupied by OWNER will be shared proportionately between OWNER and CONTRACTOR as mutually agreed to by the parties.
 - 5. Maintain, including cleaning, temporary utilities and continuously provide consumables as required.
 - 6. Temporary utilities and temporary facilities shall be adequate for personnel using the Site and requirements of Project.
 - 7. Provide temporary utilities and temporary facilities in compliance with Laws and Regulations and, when applicable, requirements of utility owners.
- B. Provide the following temporary utilities:
 - 1. Electricity
 - 2. Lighting.
 - 3. Telephone and communications.
 - 4. Heating, ventilating, and temporary enclosures.
 - 5. Water.
 - 6. Sanitary facilities.
 - 7. First-aid facilities.
 - 8. Fire protection.

1.2 REQUIREMENTS FOR TEMPORARY UTILITIES AND TEMPORARY FACILITIES

- A. Electrical:
 - 1. Provide temporary electrical service required for the Work, including continuous power for temporary field offices and sheds. Provide temporary outlets with circuit breaker protection and ground fault protection.
- B. Lighting.
 - 1. Minimum lighting shall be five foot-candles for open areas and ten foot-candles for stairs and shops. Provide minimum of one, 300-watt lamp every 15 feet in indoor Work areas. Provide night security lighting of five foot-candles, minimum, within 50 feet of all parts of the Site during hours of darkness, controlled by photocell.

- C. Telephone and Communications.
 - 1. Provide temporary telephone and communications required for CONTRACTOR's operations at the Site and for summoning emergency medical assistance.
- D. Heating, Ventilating, and Enclosures.
 - 1. Provide sufficient temporary heating, ventilating, and enclosures to ensure safe working conditions and prevent damage to existing facilities and the Work.
 - 2. Except where otherwise specified, temporary heating shall maintain temperature of the area served between 50 degrees F and maximum design temperature of building or facility and its contents.
 - 3. Maintain temperature of areas occupied by OWNER's personnel or electronic equipment, including offices, lunchrooms, locker rooms, toilet rooms, and rooms containing computers, microprocessors, and control equipment, between 65 degrees F and 80 degrees F with relative humidity less than 75 percent.
 - 4. Required temperature range for storage areas and certain elements of the Work, including preparation of materials and surfaces, installation or application, and curing as applicable, shall be in accordance with the Contract Documents for the associated Work and the Supplier's recommended temperature range for storage, application, or installation, as appropriate.
 - 5. Provide temporary ventilation sufficient to prevent accumulation in construction areas and areas occupied by OWNER of hazardous and nuisance levels or concentrations of dust and particulates, mist, fumes or vapors, odors, and gases, associated with construction.
 - 6. Provide temporary enclosures and partitions required to maintain required temperature and humidity.
- E. Water.
 - 1. Provide temporary water facilities including piping, valves, meters if not provided by owner of existing waterline, backflow preventers, pressure regulators, and other appurtenances. Provide freeze-protection as required.
 - 2. Provide water for temporary sanitary facilities, field offices, Site maintenance and cleaning and, when applicable, disinfecting and testing of systems.
 - 3. Continuously maintain adequate water flow and pressure for all purposes during the Project, until removal of temporary water system.
- F. Sanitary Facilities.
 - 1. Provide suitably-enclosed chemical or self-contained toilets for CONTRACTOR's employees and visitors to the Site. Location of temporary toilets shall be acceptable to OWNER.
 - 2. Provide supply of potable drinking water and related facilities and consumables for all personnel using the Site.
 - 3. Provide suitable temporary washing facilities for employees and visitors.
- G. First-aid Facilities.
 - 1. Provide temporary first-aid stations at or immediately adjacent to the Site's major work areas, and inside CONTRACTOR's temporary field office.

Locations of first-aid stations shall be determined by CONTRACTOR's safety representative.

2. Provide list of emergency telephone numbers at each hardwired telephone at the Site. List shall be in accordance with the list of emergency contact information required in Section 01 31 19, Pre-Construction Conference.

H. Fire Protection.

1. Provide temporary fire protection, including portable fire extinguishers rated not less than 2A or 5B in accordance with NFPA 10, Portable Fire Extinguishers, for each temporary building and for every 3,000 square feet of floor area under construction.
2. Comply with NFPA 241, Safeguarding Building Construction, Alteration, and Demolition Operations, and requirements of fire marshals and authorities having jurisdiction at the Site.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for temporary systems may be new or used, but shall be adequate for purposes intended and shall not create unsafe conditions, and shall comply with Laws and Regulations.
- B. Provide required materials, equipment, and facilities, including piping, wiring, and controls.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install temporary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.
- B. Location of Temporary Utilities and Temporary Facilities:
 1. Locate temporary systems for proper function and service.
 2. Temporary systems shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility companies.
 3. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.
- C. Modify and extend temporary systems as required by progress of the Work.

3.2 USE

- A. Maintain temporary systems to provide safe, continuous service as required.
- B. Properly supervise operation of temporary systems:
 1. Enforce compliance with Laws and Regulations.
 2. Enforce safe practices.

3. Prevent abuse of services.
 4. Prevent nuisances and hazards caused by temporary systems and their use.
 5. Prevent damage to finishes.
 6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.
- C. At end of each work day, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient.

3.3 REMOVAL

- A. Completely remove temporary utilities, facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore to preconstruction condition.
- B. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner.
- C. When permanent utilities and systems that were used for temporary utilities, upon Substantial Completion replace all consumables such as filters and light bulbs and parts used during the Work.

+ + END OF SECTION + +

SECTION 01 51 41

TEMPORARY PUMPING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide labor, materials, tools, equipment, and incidentals shown, specified and required for temporary pumping and handling of fluids during the Work.
2. Design and provide temporary pumping systems, including plugs, bulkheads, and line stops as required; pumps; piping, supports, and valves; temporary instrumentation and control system; fuel and electricity; personnel; and appurtenances. Conform to Laws and Regulations and requirements of authorities having jurisdiction. System shall be suitable for its service and operating environment.
3. Provide temporary pumping system of required capacity with at least one of the largest pumps out of service.
4. Location of the temporary pumping system shall not affect OWNER's operations and access at the Site, and public access to streets and drives, unless approved by ENGINEER and authorities having jurisdiction.
5. Provide electricity and fuel as required for temporary pumping system. Secondary containment for fuel tanks shall be in accordance with Laws and Regulations.
6. Leakage from temporary pumping system or improper discharge is not allowed.

B. Coordination:

1. Review installation procedures under other Sections and coordinate Work that must be performed with or before Work specified in this Section.

C. Related Sections:

1. Section 01 14 16, Coordination with Owner's Operations.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Temporary pumping system Supplier shall have at least five years of experience providing temporary pumping systems, and shall submit evidence of furnishing five temporary pumping systems on other projects similar in size and service to temporary pumping system required for the Project.

B. Component Supply and Compatibility: Obtain each temporary pumping system from a single Supplier who shall be responsible for providing a complete system.

1.3 SUBMITTALS

- A. Timing: Furnish submittals for temporary pumping system to ENGINEER at least 45 days prior to delivery of temporary pumping system to the Site.
- B. Action Submittals: Submit the following:
 - 1. Temporary Pumping System Submittal: Submit the following for each temporary pumping system:
 - a. Manufacturer's data and specifications on each type and size of pump proposed and its capacity, including pump curves. Provide manufacturer's data and specifications for generators and other equipment required for temporary pumping system.
 - b. Technical information and specifications on noise controls for noise-generating equipment.
 - c. Technical data on temporary piping, pipe joints, valves, pipe supports, controls, flow meter, secondary containment for fuel tanks, and other information pertinent to the temporary pumping system.
 - d. Layout Drawings:
 - 1) Sketches showing proposed layout of temporary pumping system, including locations of temporary plugs, bulkheads, and line stops; suction and discharge locations; location of pumps and associated piping and valves; and source of power for temporary pumping system. Sketches shall be scale drawings acceptable to ENGINEER, and shall include site plans similar to those in the Contract Documents.
 - 2) Details of system suction and discharge locations. Discharge details shall include measures to protect the receiving structure and dissipate energy.
 - 3) Where temporary lines will be buried, submit trench details. Submit sketches and information on other types of protection proposed for temporary piping.
 - e. System curve of flow plotted against total dynamic head, and calculations that substantiate the proposed temporary pumping system, including comparison of net positive suction head required and net positive suction head available.
 - f. Temporary Plugs, Bulkheads, and Line Stops: Manufacturer's literature and fabrication drawings showing type of plug, bulkhead or line stop as applicable, materials, and hydrostatic head the plug, bulkhead, or line stop is designed to withstand. Submit complete technical information for CONTRACTOR-proposed line stops, installation procedures, name of proposed line stop installer, and documentation of experience on at least five similar projects.
 - g. Narrative on temporary pumping system operation, including who will operate the system, staffing, planned frequency of fueling, contingency plan in event of pump failure, and statement of existing systems that may be affected during operation of temporary pumping system.
 - h. Schedule for temporary pumping system set-up, testing, use, and removal from the Site.
- C. Informational Submittals: Submit the following:
 - 1. Qualifications Statements:
 - a. Qualifications of temporary pumping system Supplier.

PART 2 – PRODUCTS

2.1 TEMPORARY PUMPING SYSTEM

- A. General:
 - 1. System components shall be suitable for continuous operation with the fluid pumped.
 - 2. Provide noise controls for temporary pumping system. Noise emissions from temporary pumping system shall conform to Laws and Regulations and shall not exceed 70 db at a distance of thirty feet from noise source.
 - 3. Fuel consuming temporary pumping system components intended for use when CONTRACTOR is not present shall include fuel tanks sized for at least twenty-four hours of uninterrupted operation at system's operating capacity, and means to automatically notify CONTRACTOR upon high and low suction water level and low fuel level.
- B. Instrumentation and Controls:
 - 1. Controls: Provide controls for temporary pumping system in accordance with Section 01 14 16, Coordination with Owner's Operations.
- C. Temporary Piping System:
 - 1. Piping shall be steel, ductile iron, high density polyethylene, or other material accepted by ENGINEER, and suitable for system operating pressures. Aluminum piping and PVC piping not mechanically restrained are not allowed. Hoses can be used only for short sections and with acceptance by ENGINEER.
 - 2. Piping system shall have watertight joints of the following types: fused joints, restrained couplings, flanged coupling adapters, quick-connects by Camlok or equal, flanged joints, grooved and shouldered end-type couplings, and other watertight joints accepted by ENGINEER.
 - 3. Size discharge piping for maximum velocity of 10 feet per second.
 - 4. Provide check valves or approved pump control valves as required.
 - 5. Provide air valves on discharge piping as required. Air valves shall expel air upon pipe filling and admit air upon pipe dewatering, and release small amounts of entrained air during operation. Air valves shall be suitable for service with the pumped fluid.
 - 6. Discharge from temporary pumping system shall not adversely affect the existing process or facilities. Provide energy dissipating measures at discharge point as required.
- D. Temporary Plugs, Bulkheads, and Line Stops:
 - 1. Acceptable temporary plugs and bulkheads include inflatable dams specifically designed for such service, brick bulkheads, timber bulkheads, sandbags, and other bulkhead methods suitable for the service. Line stops, where required, are specified in Division 40 of the Contract Documents.
 - 2. Each plug, temporary bulkhead, and line stop shall be suitable for the maximum pressure encountered.
 - 3. Where temporary plugs and bulkheads are under pressure or surcharged, provide either two plugs or a plug and temporary bulkhead.

PART 3 – EXECUTION

3.1 PREPARATION

A. General:

1. Temporary piping shall be located off of roads, driveways, and sidewalks. Piping shall not be located in environmentally sensitive areas such as wetlands.
2. Where required for OWNER's access to and operation of existing facilities, bury temporary piping that would otherwise inhibit access to processes, buildings, streets, and driveways. In paved areas, provide temporary surfacing, sufficient for AASHTO H-20 wheel loads over buried temporary piping.
3. Perform successful hydrostatic testing of temporary piping system using clean water at pressure equal to 1.2 times highest expected system operating pressure, for one hour while maintaining test pressure within 3.0 psi of required test pressure. ENGINEER will witness hydrostatic test. Hydrostatic test criteria for acceptance: No leakage.
4. Verify that entire temporary pumping system is ready for operation before commencing shutdown of OWNER's operations, facility, or systems. Verify that temporary pumping system controls and flow meter are properly connected and functional.

3.2 TEMPORARY PUMPING

A. During Operation of the Temporary Pumping System:

1. Temporary pumping system shall operate continuously. In the event of equipment failure, immediately make repairs or replace equipment. Provide spare parts and redundant units as necessary for continuous operation. The maximum amount of time the temporary pumping system can be out of service is 30 minutes.
2. Provide personnel to monitor, operate, and maintain temporary pumping system twenty-four hours per day when system is in service.

3.3 DEMOBILIZATION

A. Upon Conclusion of Temporary Pumping:

1. Remove plugs, bulkheads, and line stops in manner that allows flow to slowly return to normal, without surging, surcharging, and adverse effects on existing system.
2. Flush out temporary pumping system with clean water discharged to an appropriate location.
3. Remove temporary pumping system and appurtenances from the Site.

+ + END OF SECTION + +

SECTION 01 52 13

CONTRACTOR'S FIELD OFFICE AND SHEDS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide field office for CONTRACTOR's use with at least the minimum facilities specified.
 - 2. Provide required storage and work sheds.
 - 3. Pay for required permits and utilities. Field offices and sheds shall comply with Laws and Regulations.
- B. Location:
 - 1. Locate field offices and sheds in accordance with the Contract Documents and in accordance with the Site mobilization discussions at the preconstruction conference.
- C. Furnish in field office one complete set of the Contract Documents for ready reference by interested parties. In addition to the reference set, comply with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 FIELD OFFICE AND SHEDS, FURNISHINGS, AND EQUIPMENT

- A. Field Office and Furnishings:
 - 1. Construction: As required by CONTRACTOR and sufficient for Project meetings.
 - 2. Utilities and Services: Provide the following:
 - a. Water (may be bottled).
 - b. Facilities as required for CONTRACTOR needs.
 - c. Utilities and related facilities for lighting and maintaining temperature.
 - 3. Furnishings:
 - a. Conference Facilities: Provide conference area with conference table and chairs sufficient for six people. Conference facilities and furnishings shall be provided with suitable utilities, lighting, and temperature controls prior to the first progress meeting, unless otherwise approved by ENGINEER.
 - b. Other furnishings required by CONTRACTOR.
 - 4. Provide on field office an exterior identification sign displaying CONTRACTOR's company name. Maximum size of sign shall be four feet by eight feet. Sign shall be suitable for outdoor use for the duration of the Project.
 - 5. Furnish and maintain at CONTRACTOR's field office four protective helmets for use by visitors to the Site.
- B. Storage and Work Sheds:
 - 1. Provide storage and work sheds sized, furnished, and equipped to accommodate personnel, materials, and equipment involved in the Work,

including temporary utility services and facilities required for environmental controls sufficient for personnel, materials, and equipment.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Installation:
 - 1. Install field offices, sheds, and related facilities in accordance with Laws and Regulations.
 - 2. Install materials and equipment, including prefabricated structures, in accordance with manufacturer's instructions.

3.2 MAINTENANCE AND REMOVAL

- A. Maintenance:
 - 1. Clean and maintain field offices and sheds as required.
 - 2. Provide consumables as required.
- B. Removal:
 - 1. Do not remove field offices and sheds until after Substantial Completion of the entire Work, unless otherwise approved by ENGINEER.
 - 2. Remove field offices and sheds and restore areas prior to final inspection.

+ + END OF SECTION + +

SECTION 01 57 05

TEMPORARY CONTROLS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide and maintain methods, equipment, and temporary construction as required to control environmental conditions at the Site and adjacent areas.
 - 2. Maintain controls until no longer required.
 - 3. Temporary controls include, but are not limited to, the following:
 - a. Erosion and sediment controls.
 - b. Noise controls.
 - c. Dust control.
 - d. Pest and rodent control.
 - e. Control of water, including storm water runoff.
 - f. Pollution control.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable provisions and recommendations of jurisdictions having authority, including, but not limited to:
 - 1. Florida Department of Environmental Protection.
 - 2. Florida Department of Transportation.

PART 2 – PRODUCTS

2.1 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS

- A. Materials for temporary erosion and sediment controls shall be as shown or indicated on the Drawings.
- B. Silt Fencing:
 - 1. Filter Cloth:
 - a. Mirafi Envirofence, or equal.
 - b. Height: 18 inches, minimum.
 - c. Securely fasten filter cloth to wire mesh using ties spaced at maximum intervals of two feet on centers at top and mid-height of wire mesh, as required and shown.
 - 2. Wire Mesh: Support filter cloth with wire mesh complying with the following:
 - a. Woven wire mesh, 14-gauge steel wire, maximum mesh size six-inch by six-inch.
 - b. Height: To match filter cloth height.
 - c. Fasten wire mesh to fence supports with wire ties or staples.
 - 3. Fence Support Posts:
 - a. Length: Three feet, minimum.
 - b. Material: Metal or other acceptable material with "U" or "I" cross section, or minimum 1.25-inch by 1.25-inch hardwood.

- C. Filter Sock –
 - 1. Composite filter sock material shall meet the Sarasota County requirements.
- D. Mulch Materials and Soil Stabilization.
 - 1. Mulch shall be unrotted straw or salt hay.
 - 2. Soil stabilization emulsions, when used, shall be an inert, eco-friendly chemical manufactured for the specific purpose of erosion control and soil stabilization, applied with mulch or stabilization fibers.
 - 3. Wood-fiber or paper-fiber, when used, shall be 100 percent natural and biodegradable.
 - 4. Erosion control mat or netting shall be biodegradable. Acceptable materials include jute, excelsior, straw or coconut fiber, and cotton.
- E. Protection of Storm Water Drainage Inlets and Catch Basins:
 - 1. Inlet Filter Bag:
 - a. Product and Manufacturer: Provide one of the following for each drainage inlet or catch basin to be protected:
 - 1) Silt Sack, by Atlantic Construction Fabrics (ACF) Environmental
 - 2) Or equal.
 - b. Inlet filter bag permeability shall be not less than 40 gallons per square foot of bag area exposed to the flow. Fabric shall be woven polypropylene with double stitching to prevent bursting.
 - c. Inlet filter bags shall fit inside the drainage inlet or catch basin and shall be secured by the structure's grate or by other acceptable means.
 - d. Inlet filter bags shall have means of removing inlet filter bag and the silt and sediment collected in the bag, without dumping filter bag's contents into the drainage inlet or catch basin.
 - 2. Silt fence barrier, as shown.
- F. Temporary Settlement Basin.
 - 1. Embankment Material: Comply with requirements for general fill in Section 31 23 05, Excavation and Fill
 - 2. Provide outfall structure consisting of overflow weir and discharge pipe, and provide emergency spillway.
 - 3. Overflow Weir and Discharge Pipe: Suitably-sized piping of corrugated metal, high-density polyethylene, or other suitable material. Pipe may be new or used; if used, pipe shall be in good condition.
- G. Filter Bag on Dewatering Pump Discharge:
 - 1. Provide filter bag on discharge of each dewatering pump drawing from an excavation. Filter bag is not required on pumps associated with dewatering wells.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. UltraTech Dewatering Bag, by Interstate Products.
 - b. Filter Bag, by US Fabrics.
 - c. Dewatering (Filter) Bag, Indian Valley Industries.
 - d. DirtBag, by Atlantic Construction Fabrics (ACF) Environmental
 - e. Or equal.
 - 3. Size filter bags for maximum flow of the pump. Filter bags shall be specifically fabricated for use as a dewatering pump filter bag.

4. Provide sufficient spare filter bags for continuous dewatering operations.
- H. Temporary Stone Construction Entrance:
1. Stone: Tough, hard, durable stone complying with the following gradation requirements:

Sieve Size	Total Percent Passing
Four-inch (100 mm)	100
3.5-inch (90 mm)	90 to 100
2.5-inch (65 mm)	25 to 60
1.5-inch (37.5 mm)	Zero to 15

2. Geotextile: As recommended by geotextile manufacturer for separating stone from subgrade, for the vehicle weight and traffic frequency required.

PART 3 – EXECUTION

3.1 NOISE CONTROL

- A. Noise Control – General:
1. CONTRACTOR's vehicles and equipment shall minimize noise emissions to greatest degree practicable. Provide mufflers, silencers, and sound barriers when necessary.
 2. Noise levels shall comply with Laws and Regulations, including OSHA requirements and local ordinances.
 3. Noise emissions shall not interfere with the work of OWNER or others.

3.2 DUST CONTROL

- A. Dust Control – General:
1. Control objectionable dust caused by CONTRACTOR's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of ENGINEER and approval of authorities having jurisdiction.
 2. CONTRACTOR shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on- and off-Site damage, nuisances, and health hazards associated with dust emissions. Control may be achieved by irrigation in which the Site shall be sprinkled with water until the surface is moist. Apply dust controls as frequently as required without creating nuisances such as excessive mud and ponding of water at the Site.
 3. Remove dust from roadways and access roads at maximum intervals of seven days by mechanical brooming or other method acceptable to ENGINEER.

3.3 PEST AND RODENT CONTROL

- A. Pest and Rodent Control – General:
1. Provide rodent and pest control as required to prevent infestation of the Site and storage areas.
 2. Employ methods and use materials that do not adversely affect conditions at the Site or on adjoining properties.

3. In accordance with Laws and Regulations, promptly and properly dispose of pests and rodents trapped or otherwise controlled.

3.4 WATER CONTROL

- A. Water Control – General:
 1. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the Site, and adjoining properties.
 2. Control fill, grading, and ditching to direct water away from excavations, pits, tunnels and other construction areas and to direct drainage to proper runoff courses to prevent erosion, damage, or nuisance.
- B. Equipment and Facilities for Water Control: Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
- C. Discharge and Disposal: Dispose of drainage water in manner to prevent flooding, erosion, and other damage to any and all parts of the Site and adjoining areas, and that complies with Laws and Regulations.

3.5 POLLUTION CONTROL

- A. Pollution Control – General:
 1. Provide means, methods, and facilities required to prevent contamination of soil, water, and atmosphere caused by discharge of noxious substances from construction operations.
 2. Equipment used during construction shall comply with Laws and Regulations.
- B. Spills and Contamination:
 1. Provide equipment and personnel to perform emergency measures required to contain spills and to remove contaminated soils and liquids.
 2. Excavate contaminated material and properly dispose of off-Site, and replace with suitable compacted fill and topsoil.
- C. Protection of Surface Waters: Implement special measures to prevent harmful substances from entering surface waters. Prevent disposal of wastes, effluents, chemicals, and other such substances in or adjacent to surface waters and open drainage routes, in sanitary sewers, or in storm sewers.
- D. Atmospheric Pollutants:
 1. Provide systems for controlling atmospheric pollutants related to the Work.
 2. Prevent toxic concentrations of chemicals and vapors.
 3. Prevent harmful dispersal of pollutants into atmosphere.
- E. Solid Waste:
 1. Provide systems for controlling and managing solid waste related to the Work.
 2. Prevent solid waste from becoming airborne, and from discharging to surface waters and drainage routes.
 3. Properly handle and dispose of solid waste.

3.6 EROSION AND SEDIMENT CONTROL

- A. Installation and Maintenance of Erosion and Sediment Controls – General:
1. General:
 - a. Provide erosion and sediment controls as shown and indicated on the Drawings and elsewhere in the Contract Documents. Provide erosion and sediment controls as the Work progresses into previously undisturbed areas.
 - b. Installation of erosion and sediment controls shall be in accordance with the applicable regulatory requirements indicated in Article 1.2 of this Section, unless otherwise shown or indicated in the Contract Documents.
 - c. Use necessary methods to successfully control erosion and sedimentation, including ecology-oriented construction practices, vegetative measures, and mechanical controls. Use best management practices (BMP) in accordance with Laws and Regulations, and regulatory requirements indicated in Article 1.2 of this Section, to control erosion and sedimentation during the Project.
 - d. Plan and execute construction, disturbances of soils and soil cover, and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation. Provide temporary measures for controlling erosion and sedimentation, as indicated in the Contract Documents and as required for the Project.
 - e. Where areas must be cleared for storage of materials or equipment, or for temporary facilities, provisions shall be made for regulating drainage and controlling erosion and sedimentation, subject to the ENGINEER'S approval.
 - f. Provide erosion and sediment controls, including stabilization of soils, at the end of each workday.
 2. Coordination:
 - a. Coordinate temporary erosion and sediment controls with construction of permanent drainage facilities and other Work to the extent necessary for economical, effective, and continuous erosion and sediment control.
 3. Before commencing activities that will disturb soil or soil cover at the Site, provide all erosion and sediment control measures required by the Contract Documents for the areas where soil or soil cover will be disturbed.
 4. In general, implement construction procedures associated with, or that may affect, erosion and sediment control to ensure minimum damage to the environment during construction. CONTRACTOR shall implement any and all additional measures required to comply with Laws and Regulations.
 5. Vegetation Removal: Remove only those shrubs, grasses, and other vegetation that must be removed for construction. Protect remaining vegetation.
 6. Access Roads and Parking Areas: When possible, access roads and temporary roads shall be located and constructed to avoid adverse effects on the environment. Provisions shall be made to regulate drainage, avoid erosion and sedimentation, and minimize damage to vegetation.
 7. Earthwork and Temporary Controls:
 - a. Perform excavation, fill, and related operations in accordance with Section 31 23 05, Excavation and Fill
 - b. Control erosion to minimize transport of silt from the Site into existing waterways and surface waters. Such measures shall include, but are

not limited to, using berms, silt fencing, baled straw silt barriers, gravel or crushed stone, mulching and soil stabilization, slope drains, and other methods. Apply such temporary measures to erodible materials exposed by activities associated with the construction of the Project.

- c. Hold to a minimum the areas of bare soil exposed at one time.
 - d. Construct fills and waste areas by selectively placing fill and waste materials to eliminate surface silts and clays that will erode.
 - e. In performing earthwork, eliminate depressions that could serve as mosquito pools.
 - f. CONTRACTOR shall provide special care in areas with steep slopes, where disturbance of vegetation shall be minimized to maintain soil stability.
8. Inspection and Maintenance:
- a. Periodically inspect areas of earthwork and areas where soil or soil cover are disturbed to detect evidence of the start of erosion and sedimentation; apply corrective measures as required to control erosion and sedimentation. Continue inspections and corrective measures until soils are permanently stabilized and permanent vegetation has been established
 - b. Repair or replace damaged erosion and sediment controls within 24 hours of CONTRACTOR becoming aware of such damage.
 - c. Periodically remove silt and sediment that has accumulated in or behind sediment and erosion controls. Properly dispose of silt and sediment.
9. Duration of Erosion and Sediment Controls:
- a. Maintain erosion and sediment controls in effective working condition until the associated drainage area has been permanently stabilized.
 - b. Maintain erosion and sediment controls until the Site is restored and site improvements including landscaping, if any, are complete with underlying soils permanently stabilized.
10. Work Stoppage: If the Work is temporarily stopped or suspended for any reason, CONTRACTOR shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.
11. Failure to Provide Adequate Controls: In the event CONTRACTOR repeatedly fails to satisfactorily control erosion and siltation, OWNER reserves the right to employ outside assistance or to use OWNER's own forces for erosion and sediment control. Cost of such work, plus engineering and inspection costs, will be deducted from monies due CONTRACTOR.

B. Silt Fencing:

- 1. Install and maintain silt fencing in a vertical plane, at the location(s) shown or indicated on the Drawings.
- 2. Locations of Silt Fencing:
 - a. Where possible, install silt fencing along contour lines so that each given run fencing is at the same elevation.
 - b. On slopes install silt fencing at intervals that do not exceed the maximum intervals indicated in the following table:

Slope (percent)	Maximum Length of Slope Above Each Silt Fence (feet)

2 and less	150
2.1 to 5	100
5.1 to 10	50
10.1 to 20	25
20.1 to 25	20
25.1 to 40	15
40.1 to 50	10

- c. Provide silt fencing around perimeter of each stockpile of topsoil, general fill material, and excavated material. Install silt fencing before expected precipitation and maintain until stockpile is removed.
 - d. Do not install silt fencing at the following types of locations:
 - 1) Area of concentrated storm water flows such as ditches, swales, or channels.
 - 2) Where rock or rocky soils prevent full and uniform anchoring of silt fencing.
 - 3) Across upstream or discharge ends of storm water piping or culverts.
 - 3. Installation:
 - a. Securely fasten wire mesh to posts, and securely fasten filter cloth to wire mesh.
 - b. When two sections of filter cloth abut each other, fold over edges and overlap by minimum of six inches and securely fasten to wire mesh.
 - c. Embed posts in the ground to the depth necessary for proper controls; embed posts to at least 16 inches below ground.
 - d. Filter cloth and wire mesh shall extend a minimum of eight inches below ground and a minimum of 16 inches above ground.
 - e. Remove sediment accumulated at silt fencing as required. Repair and reinstall silt fencing as required.
 - 4. Maintenance:
 - a. Do not allow formation of concentrated storm water flows on slopes above silt fencing unless so shown or indicated in the Contract Documents. If unauthorized concentrated storm water flows occur, stabilize the slope via earthmoving and other stabilization measures as required to prevent flow of concentrated storm water flows toward silt fencing.
- C. Straw Bale Dike.
- 1. Install straw bale dikes where shown or indicated, including in swales, along contours, and along toe of slopes.
 - 2. Install bales in shallow excavation as wide as the bale and approximately four to six inches below surrounding grade.
 - 3. Ends of bale shall tightly abut ends of adjacent bales.
 - 4. Securely install straw bales using two support posts per bale, driven into the ground a minimum of 1.5 to two feet below bottom of bale. Top of post shall be flush with top of bale. Angle first post for each bale toward the previously-installed bale.
 - 5. Frequently inspect bales and repair or replace as required. Remove accumulated silt and debris from behind straw bales.
- D. Mulching and Soil Stabilization:
- 1. Use mulching to temporarily stabilize exposed soil and fill material.

- a. Immediately following final grading, provide mulch and stabilize with mats or netting, or sprayed soil stabilization emulsion with fiber additive.
 - b. Application of mulching for soil stabilization shall be as follows.
 - 1) Unrotted Straw or Salt Hay: 1.5 to two tons per acre.
 - 2) Soil stabilization emulsions, when used, shall be applied in accordance with manufacturer's instructions, and shall be applied with mulch or stabilization fibers.
 - 3) Wood-fiber or Paper-fiber Application: 1,500 lbs. per acre, installed by hydroseeding.
 - c. Where mats or netting are used:
 - 1) Cover entire area to be stabilized with mats or netting.
 - 2) Provide anchoring trenches at the top and bottom of slopes to receive mats or netting. Bury at least the top and bottom ends of mat or netting, four inches or more wide, at top and bottom of slope. Tamp trench full of soil. Four inches from trench, secure mat or netting with appropriate staples spaced at intervals of 10 inches.
 - 3) Overlap adjacent strips of mat or netting by at least four inches.
- E. Protection of Storm Water Drainage Inlets and Catch Basins:
- 1. Protect each drainage inlet and catch basin that has the potential to receive storm water runoff from exposed soils, and does not discharge into a storm water settlement basin.
 - 2. Install either, inlet filter bags inside of drainage inlet or catch basin, or a silt fence barrier around drainage inlets and catch basins. Secure inlet filter bag with the structure's grate or by other acceptable means.
 - 3. Inlet filter bags shall not pose any obstruction above the elevation of the drainage inlet or catch basin grate requiring barricades or flashers.
 - 4. When removing silt and sediment from inlet filter bag, do not dump filter bag's contents into the drainage inlet or catch basin.
 - 5. Remove silt and sediment from inlet filter bag, or replace inlet filter bag, when inlet filter bag is not more than half full.
- F. Temporary Settlement Basin.
- 1. For constructing embankments comply with requirements in Section 31 23 05, Excavation and Fill.
 - 2. Overflow Weir and Discharge Pipe:
 - a. Install piping in accordance with manufacturer's instructions.
 - b. Install overflow weirs at elevations on shown or indicated on the Drawings or approved Shop Drawings, as applicable, to avoid overtopping and overfilling of settlement basin without short-circuiting the settlement basin's hydraulics.
 - c. Wrap geotextile material specified for silt fencing around discharge structures of temporary settlement basins
 - 3. Crushed Stone and Riprap: Install in accordance with Division 31. Provide in areas of temporary settlement basin subject to erosion, and at upstream and downstream ends of discharge piping.
 - 4. Remove sediment when required based on accumulation of material.
 - 5. When temporary settlement basin is no longer required, remove the temporary settlement basin discharge weir, discharge pipe, and spillway, fill the temporary sediment basin to required grade in accordance with requirements of Division 31 Section on excavation and fill..

- G. Filter Bag on Dewatering Pump Discharge:
1. Provide dewatering of excavations in compliance with Section 31 23 05, Excavation and Fill
 2. Locate filter bags and temporary pump discharge lines to avoid interfering with the public, use of private property, and OWNER's operations. Relocate filter bags and appurtenances when required.
 3. Filter bag discharge shall be directed to appropriate storm water drainage route. Do not discharge into roadways, driveways, or access roads. When temporary settlement basin is used, locate filter bags to discharge to temporary settlement basin when practicable.
 4. Provide filter bag on discharge of each dewatering pump drawing from an excavation.
 5. Securely attach filter bag to pump discharge pipe or hose.
 6. Maintain, clean out, and replace filter bags as required.
- H. Temporary Stone Construction Entrance:
1. Where shown on the Drawings, and where construction vehicles will regularly transit to paved surfaces from unstabilized surfaces, provide a temporary stone construction entrance. Contractor vehicles shall use temporary construction entrances.
 2. Provide temporary stone construction entrances of the width, length, and thickness shown or indicated on the Drawings. When not shown or indicated on the Drawings, temporary stone construction entrance shall be not less than 50 feet long, by 20 feet wide, by eight inches deep.
 3. Installation:
 - a. Ensure that subgrade under temporary stone construction entrance is suitably dense for the intended purpose. Suitably prepare subgrade as required for temporary construction entrance.
 - b. Provide on subgrade a layer of geotextile fabric, installed in accordance with geotextile manufacturer's recommendations for separation.
 - c. Provide stone on installed geotextile. Grade stone for passage of vehicles.
 4. Maintenance:
 - a. Maintain temporary stone construction entrance at not less than the minimum required thickness. Add stone as required to maintain thickness.
 - b. When upper layer of temporary stone construction entrance becomes contaminated with soil, remove the contaminated material and replace with clean stone.
 - c. Using water to wash down temporary construction entrance or paved areas onto which soil material has been tracked is not allowed.

3.7 REMOVAL OF TEMPORARY CONTROLS

- A. Removals – General:
1. Upon completion of the Work, remove temporary controls and restore Site to pre-construction condition.
 2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls.

+ + END OF SECTION + +

SECTION 01 65 00

PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes the general requirements for preparing for shipping, delivering, and handling materials and equipment.
2. CONTRACTOR shall make all arrangements for transporting, delivering, and handling of materials and equipment required for prosecution and completion of the Work.
3. When required, move stored materials and equipment without additional compensation and without changes to the Contract Times.

1.2 SUBMITTALS

- ###### A.
- Refer to individual Specification Sections for submittal requirements relative to delivering and handling materials and equipment.

1.3 PREPARING FOR SHIPMENT

- ###### A.
- When practical, factory-assemble materials and equipment. Match mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable, protective coating.
- ###### B.
- Package materials and equipment to facilitate handling, and protect materials and equipment from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate the associated purchase order number, bill of lading number, contents by name, OWNER's contract name and number, CONTRACTOR name, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.
- ###### C.
- Protect materials and equipment from exposure to the elements and keep thoroughly dry and dust-free at all times. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Lubricate bearings and other items requiring lubrication in accordance with manufacturer's instructions.
- ###### D. Advance Notice of Shipments:
1. Keep ENGINEER informed of delivery of all materials and equipment to be incorporated in the Work.
 2. Upon receipt of Supplier's advance notice of shipment, at least seven days prior to delivery of materials and equipment, provide ENGINEER written notification of anticipated date and place of arrival of the following:
 - a. Packaged Lift Station.
 - b. Packaged Wastewater Treatment Plant.

- E. Do not ship materials and equipment until:
1. Related Shop Drawings and other submittals have been approved or accepted (as applicable) by ENGINEER, including, but not necessarily limited to, all Action Submittals associated with the materials and equipment being delivered.
 2. Manufacturer's instructions for handling, storing, and installing the associated materials and equipment have been submitted to and accepted by ENGINEER in accordance with the Specifications.
 3. Results of source quality control testing (factory testing), when required by the Contract Documents for the associated materials or equipment, have been reviewed and accepted by ENGINEER.
 4. Facilities required for handling materials and equipment in accordance with manufacturer's instructions are in place and available.
 5. Required storage facilities have been provided.

1.4 DELIVERY

- A. Scheduling and Timing of Deliveries:
1. Arrange deliveries of materials and equipment in accordance with the accepted Progress Schedule and in ample time to facilitate inspection prior to installation.
 2. Schedule deliveries to minimize space required for and duration of storage of materials and equipment at the Site or delivery location, as applicable.
 3. Coordinate deliveries to avoid conflicting with the Work and conditions at Site, and to accommodate the following:
 - a. Work of other contractors and OWNER.
 - b. Storage space limitations.
 - c. Availability of equipment and personnel for handling materials and equipment.
 - d. OWNER's use of premises.
 4. Deliver materials and equipment to the Site during regular working hours.
 5. Deliver materials and equipment to avoid delaying the Work and the Project, including work of other contractors, as applicable. Deliver anchor system materials, including anchor bolts to be embedded in concrete or masonry, in ample time to avoid delaying the Work.
- B. Deliveries:
1. Shipments shall be delivered with CONTRACTOR's name, Subcontractor's name (if applicable), Site name, Project name, and contract designation (example: "ABC Construction Co., City of Somewhere, Idaho, Wastewater Treatment Plant Primary Clarifier Improvements, Contract 25, General Construction") clearly marked.
 2. Site may be listed as the "ship to" or "delivery" address; but OWNER shall not be listed as recipient of shipment unless otherwise directed in writing by ENGINEER.
 3. Provide CONTRACTOR's telephone number to shipper; do not provide OWNER's telephone number.
 4. Arrange for deliveries while CONTRACTOR's personnel are at the Site. CONTRACTOR shall receive and coordinate shipments upon delivery. Shipments delivered to the Site when CONTRACTOR is not present will

be refused by OWNER, and CONTRACTOR shall be responsible for the associated delays and additional costs, if incurred.

- C. Containers and Marking:
 - 1. Have materials and equipment delivered in manufacturer's original, unopened, labeled containers.
 - 2. Clearly mark partial deliveries of component parts of materials and equipment to identify materials and equipment, to allow easy accumulation of parts, and to facilitate assembly.
- D. Inspection of Deliveries:
 - 1. Immediately upon delivery, inspect shipment to verify that:
 - a. Materials and equipment comply with the Contract Documents and approved or accepted (as applicable) submittals.
 - b. Quantities are correct.
 - c. Materials and equipment are undamaged.
 - d. Containers and packages are intact and labels are legible.
 - e. Materials and equipment are properly protected.
 - 2. Promptly remove damaged materials and equipment from the Site and expedite delivery of new, undamaged materials and equipment, and remedy incomplete or lost materials and equipment to furnish materials and equipment in accordance with the Contract Documents, to avoid delaying progress of the Work.
 - 3. Advise ENGINEER in writing when damaged, incomplete, or defective materials and equipment are delivered, and advise ENGINEER of the associated impact on the Progress Schedule.

1.5 HANDLING OF MATERIALS AND EQUIPMENT

- A. Provide equipment and personnel necessary to handle materials and equipment, including those furnished by OWNER, by methods that prevent soiling or damaging materials and equipment and packaging.
- B. Provide additional protection during handling as necessary to prevent scraping, marring, and otherwise damaging materials and equipment and surrounding surfaces.
- C. Handle materials and equipment by methods that prevent bending and overstressing.
- D. Lift heavy components only at designated lifting points.
- E. Handle materials and equipment in safe manner and as recommended by the manufacturer to prevent damage. Do not drop, roll, or skid materials and equipment off delivery vehicles or at other times during handling. Hand-carry or use suitable handling equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This Section includes general requirements for storing and protecting materials and equipment.

1.2 STORAGE

- A. Store and protect materials and equipment in accordance with manufacturer's recommendations and the Contract Documents.
- B. CONTRACTOR shall make all arrangements and provisions necessary for, and pay all costs for, storing materials and equipment. Excavated materials, construction equipment, and materials and equipment to be incorporated into the Work shall be placed to avoid injuring the Work and existing facilities and property, and so that free access is maintained at all times to all parts of the Work and to public utility installations in vicinity of the Work. Store materials and equipment neatly and compactly in locations that cause minimum inconvenience to OWNER, other contractors, public travel, and owners, tenants, and occupants of adjoining property. Arrange storage in manner to allow easy access for inspection.
- C. Store materials and equipment to become OWNER's property to facilitate their inspection and ensure preservation of quality and fitness of the Work, including proper protection against damage by freezing, moisture, and high temperatures with ambient temperatures as high as 100 degrees F. Store in indoor, climate-controlled storage areas all materials and equipment subject to damage by moisture, humidity, heat, cold, and other elements, unless otherwise acceptable to OWNER. When placing orders to Suppliers for equipment and controls containing computer chips, electronics, and solid-state devices, CONTRACTOR shall obtain, coordinate, and comply with specific temperature and humidity limitations on materials and equipment, because temperature inside cabinets and components stored in warm temperatures can approach 200 degrees F.
- D. CONTRACTOR shall be fully responsible for loss or damage (including theft) to stored materials and equipment.
- E. Do not open manufacturer's containers until time of installation, unless recommended by the manufacturer or otherwise specified in the Contract Documents.
- F. Do not store materials or equipment in structures being constructed unless approved by ENGINEER in writing.
- G. Do not use lawns or other private property for storage without written permission of the owner or other person in possession or control of such premises.

1.3 PROTECTION

- A. Equipment to be incorporated into the Work shall be boxed, crated, or otherwise completely enclosed and protected during shipping, handling, and storage, in accordance with Section 01 65 00, Product Delivery Requirements.
- B. Store all materials and equipment off the ground (or floor) on raised supports such as skids or pallets.
- C. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Painted equipment surfaces that are damaged or marred shall be repainted in their entirety in accordance with equipment manufacturer and paint manufacturer requirements, to the satisfaction of ENGINEER.
- D. Protect electrical equipment, controls, and instrumentation against moisture, water damage, heat, cold, and dust. Space heaters provided in equipment shall be connected and operating at all times until equipment is placed in operation and permanently connected.

1.4 UNCOVERED STORAGE

- A. The following types of materials may be stored outdoors without cover on supports so there is no contact with the ground:
 - 1. Reinforcing steel.
 - 2. Precast concrete materials.
 - 3. Structural steel.
 - 4. Metal stairs.
 - 5. Handrails and railings.
 - 6. Grating.
 - 7. Checker plate.
 - 8. Metal access hatches.
 - 9. Castings.
 - 10. Rigid electrical conduit.
 - 11. Piping, except polyvinyl chloride (PVC) pipe.

1.5 COVERED STORAGE

- A. The following materials and equipment may be stored outdoors on supports and completely covered with covering impervious to water:
 - 1. Grout and mortar materials.
 - 2. Masonry units.
 - 3. Rough lumber.
 - 4. Soil materials and granular materials such as aggregate.
 - 5. PVC pipe.
- B. Tie down covers with rope, and slope covering to prevent accumulation of water.
- C. Store loose granular materials, with covering impervious to water, in well-drained area or on solid surfaces to prevent mixing with foreign matter.

1.6 FULLY PROTECTED STORAGE

- A. Store all material and equipment not named in Articles 1.4 and 1.5 of this Section on supports in buildings or trailers that have concrete or wooden flooring, roof, and fully closed walls on all sides. Covering with visquine plastic sheeting or similar material in space without floor, roof, and walls is not acceptable. Comply with the following:
 - 1. Provide heated storage for materials and equipment that could be damaged by low temperatures or freezing.
 - 2. Provide air-conditioned storage for materials and equipment that could be damaged by high temperatures.
 - 3. Protect mechanical and electrical equipment from being contaminated by dust, dirt, and moisture.
 - 4. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

1.7 HAZARDOUS PRODUCTS

- A. Prevent contamination of personnel, storage area, and the Site. Comply with all applicable Laws and Regulations.

1.8 MAINTENANCE OF STORAGE

- A. On scheduled basis, periodically inspect stored materials and equipment to ensure that:
 - 1. Condition and status of storage facilities is adequate to provide required storage conditions.
 - 2. Required environmental conditions are maintained on continuing basis.
 - 3. Materials and equipment exposed to elements are not adversely affected.
- B. Mechanical and electrical equipment requiring long-term storage shall have complete manufacturer's instructions for servicing each item, with notice of enclosed instructions shown on exterior of container or package.
 - 1. Comply with manufacturer's instructions on scheduled basis.
 - 2. Space heaters that are part of electrical equipment shall be connected and operated continuously until equipment is placed in service and permanently connected.

1.9 MICROPROCESSORS, PANELS, AND INSTRUMENTATION STORAGE

- A. Store panels, microprocessor-based equipment, electronics, and other devices subject to damage or decreased useful life because of temperatures below 40 degrees F or above 100 degrees F, relative humidity above 90 percent, or exposure to rain or exposure to blowing dust in climate-controlled storage space.
- B. Requirements:
 - 1. Storage shall be in third-party owned, bonded, insured, climate-controlled warehouse in Suwannee County.
 - 2. OWNER and ENGINEER have the right to inspect materials and equipment during normal working hours.
 - 3. Placed inside each panel or device a desiccant, volatile corrosion inhibitor blocks (VCI), moisture indicator, and maximum-minimum indicating

- thermometer.
4. Check panels and equipment at least once per month. Replace desiccant, VCI, and moisture indicator as often as required, or every six months, whichever occurs first.
- C. Costs for storing climate-sensitive materials and equipment shall be paid by CONTRACTOR. Replace panels and devices damaged during storage, or for which storage temperatures or humidity range has been exceeded, at no additional cost to OWNER. Delays resulting from such replacement are causes within CONTRACTOR's control.
- D. Do not ship panels and equipment to the Site until conditions at the Site are suitable for installation, including slabs and floors, walls, roofs, and environmental controls. Failure to have the Site ready for installation shall not relieve CONTRACTOR from complying with the Contract Documents.

1.10 RECORDS

- A. Keep up-to-date account of materials and equipment in storage to facilitate preparation of Applications for Payment, if the Contract Documents provide for payment for materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION +

SECTION 01 74 05

CLEANING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes requirements for keeping the Site free of accumulations of waste materials during construction ("progress cleaning") and cleaning for Substantial Completion and prior to final inspection (collectively, "closeout cleaning").
2. CONTRACTOR shall perform cleaning during the Project, including progress cleaning, upon completion of the Work, and as required by this Section.
3. Maintain in a clean manner the Site, the Work, and areas adjacent to or affected by the Work.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. NFPA 241, Safeguarding Construction, Alteration, and Demolition Operations.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PROGRESS CLEANING

A. General:

1. Clean the Site, work areas, and other areas occupied by CONTRACTOR not less than weekly. Dispose of materials in accordance with these Contract Documents, and the following:
 - a. Comply with NFPA 241 for removing combustible waste materials and debris.
 - b. Do not hold non-combustible materials at the Site more than three days if the temperature is expected to rise above 80 degrees F. When temperature is less than 80 degrees F, dispose of non-combustible materials within seven days of their generation.
 - c. Provide suitable containers for storage of waste materials and debris.
 - d. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.

B. Site:

1. Keep outdoor, dust-generating areas wetted down or otherwise control dust emissions.
2. Brush-sweep roadways and paved areas at the Site that are used by construction vehicles or otherwise affected by construction activities. Frequency shall be as needed or as directed by OWNER or ENGINEER.

- C. Work Areas:
 - 1. Clean areas where the Work is in progress to maintain the extent of cleanliness necessary for proper execution of the Work.
 - 2. Remove liquid spills promptly. Immediately report spills to OWNER, ENGINEER, and authorities having jurisdiction, in accordance with the Contract Documents and Laws and Regulations.
 - 3. Where dust would impair proper execution of the Work, broom-clean or vacuum entire work area, as appropriate.
 - 4. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- D. Installed Work:
 - 1. Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of material or equipment installed, using only cleaning agents and methods specifically recommended by material or equipment manufacturer. If manufacturer does not recommend specific cleaning agents or methods, use cleaning agents and methods that are not hazardous to health and property and that will not damage exposed surfaces.
- E. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration until Substantial Completion.
- F. Cutting and Patching:
 - 1. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, trailings and cuttings, and similar materials.
 - 2. Thoroughly clean piping, conduits, and similar features before applying patching material, paint, or other finishing materials. Restore damaged coverings on piping, ducting, and similar items to its pre-construction condition.
- G. Waste Disposal:
 - 1. Properly dispose of waste materials, surplus materials, debris, and rubbish off the Site.
 - 2. Do not burn or bury rubbish and waste materials at the Site.
 - 3. Do not discharge volatile or hazardous substances, such as mineral spirits, oil, or paint thinner, into storm sewers or sanitary sewers.
 - 4. Do not discharge wastes into surface waters or drainage routes.
 - 5. CONTRACTOR is solely responsible for complying with Laws and Regulations regarding storing, transporting, and disposing of waste generated by CONTRACTOR's operations or brought to the Site by CONTRACTOR.
- H. During handling and installation of materials and equipment, clean and protect construction in progress and adjoining materials and equipment already in place. Apply protective covering where required for protection from damage or deterioration, until Substantial Completion.
- I. Clean completed construction as frequently as necessary throughout the construction period.

3.2 CLOSEOUT CLEANING

- A. Complete the following prior to requesting inspection for Substantial Completion:
 - 1. Clean and remove from the Site rubbish, waste material, debris, and other foreign substances.
 - 2. Sweep paved areas broom-clean. Remove petrochemical spills, stains, and other foreign deposits.
 - 3. Hose-clean sidewalks and loading areas.
 - 4. Repair pavement, roads, sod, and other areas affected by construction operations and restore to specified condition; if condition is not specified, restore to pre-construction condition.
 - 5. Clean exposed exterior and interior hard-surfaced finishes to dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign substances.
 - 6. In unoccupied spaces, sweep concrete floors broom-clean.
 - 7. Remove non-permanent tags and labels.
 - 8. Surface Finishes:
 - a. Touch-up and otherwise repair and restore chipped, scratched, dented or otherwise marred surfaces to specified finish and match adjacent surfaces.
 - b. Do not paint over "UL" or similar labels, including mechanical and electrical nameplates.
 - 9. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint, and mortar droppings, and other foreign substances.
 - 10. Clean plumbing fixtures to sanitary condition, free of stains, including stains resulting from water exposure.
 - 11. Leave the Site clean, and in neat, orderly condition, satisfactory to OWNER and ENGINEER.
- B. Complete the following prior to requesting final inspection:
 - 1. Following completion of the Work on the "punch list" of Work uncompleted at Substantial Completion, clean in accordance with Paragraph 3.2.A of this Section.

+ + END OF SECTION +

SECTION 01 75 11

CHECKOUT AND STARTUP PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall initially start up and place equipment installed under the Contract into successful operation, in accordance with the equipment manufacturer's written instructions and as instructed by Supplier at the Site.
2. Provide all material, labor, tools, and equipment required to complete equipment checkout and start-up.
3. Provide chemicals, lubricants, and other required operating fluids.
4. Provide fuel, electricity, water, filters, and other expendables required for start-up of equipment, unless otherwise specified.
5. General Activities Include:
 - a. Cleaning, as required under other provisions of the Contract Documents.
 - b. Removing temporary protective coatings.
 - c. Flushing and replacing lubricants, where required by manufacturer.
 - d. Lubrication.
 - e. Checking shaft and coupling alignments and resetting where required.
 - f. Checking and setting motor, pump, and other equipment rotation, safety interlocks, and belt tensions.
 - g. Checking and correcting (if necessary) leveling plates, grout, bearing plates, anchorage devices, fasteners, and alignment of piping, conduits, and ducts that may place stress on the connected equipment.
 - h. All adjustments required.

B. Coordination:

1. Coordinate checkout and start-up with other contractors, as necessary.
2. Do not start up system or subsystem for continuous operation until all components of that system or subsystem, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
3. OWNER will provide sufficient personnel to assist CONTRACTOR in starting up equipment, but responsibility for proper operation is CONTRACTOR's.
4. Supplier shall be present during checkout, start-up, and initial operation, unless otherwise acceptable to ENGINEER.
5. Start-up of heating and air conditioning equipment and systems is dependent upon the time of year. Return to the Site at beginning of next heating or air conditioning season (as applicable) to recheck and start the appropriate systems.
6. Do not start up system, unit process, or equipment without submitting acceptable preliminary operations and maintenance manuals by CONTRAC-TOR, in accordance with Section 01 78 23, Operations and Maintenance Data.

- C. OWNER's Assumption of Responsibility for Equipment and Systems:
1. OWNER will assume responsibility for the equipment upon Substantial Completion.
 2. Prior to turning over to OWNER responsibility for operating and maintaining system or equipment:
 - a. Provide training of operations and maintenance personnel in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - b. Complete system field quality control testing in accordance with the Contract Documents.
 - c. Submit acceptable final operations and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
 - d. Obtain from ENGINEER final certificate of Substantial Completion for either entire Work or the portion being turned over to OWNER.

1.2 SUBMITTALS

- A. Closeout Submittals: Submit the following:
1. Certifications:
 - a. Supplier's certification of installation in accordance with Paragraph 3.1.B of this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SERVICES OF SUPPLIER

- A. When specified, furnish services of competent, qualified representatives of material and equipment manufacturers as specified, including supervising installation, adjusting, checkout, start-up, and testing of materials and equipment.
- B. Certification:
1. When services by Supplier are required at the Site, within 14 days after first test operation of equipment, submit to ENGINEER a letter from Supplier, on Supplier's letterhead, stating that materials and equipment are installed in accordance with Supplier's requirements and installation instructions, and in accordance with the Contract Documents.
 2. In lieu of Supplier letter, submit completed form attached to this Section.
 3. Include in the final operations and maintenance manual for the associated equipment a copy of the letter or completed form, as applicable.

3.2 MINIMUM START-UP REQUIREMENTS

- A. Bearings and Shafting:
1. Inspect for cleanliness, and clean and remove foreign matter.
 2. Verify alignment.
 3. Replace defective bearings and those that operate in a rough or noisy manner.
 4. Grease as necessary, in accordance with manufacturer's recommendations.

- B. Drives:
 - 1. Adjust tension in V-belt drives and adjust vari-pitch sheaves and drives for proper equipment speed.
 - 2. Adjust drives for alignment of sheaves and V-belts.
 - 3. Clean and remove foreign matter before starting operation.
- C. Motors:
 - 1. Check each motor for comparison to amperage nameplate value.
 - 2. Correct conditions that produce excessive current flow and conditions that exist due to equipment malfunction.
- D. Pumps:
 - 1. Check glands and seals for cleanliness and adjustment before running pump.
 - 2. Inspect shaft sleeves for scoring.
 - 3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
 - 4. Verify that piping system is free of dirt and scale before circulating liquid through pump.
- E. Valves:
 - 1. Inspect manual and automatic control valves, and clean bonnets and stems.
 - 2. Tighten packing glands to ensure no leakage, but allow valve stems to operate without galling.
 - 3. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
 - 4. Replace packing on valves that continue to leak.
 - 5. Remove and repair bonnets that leak.
 - 6. After cleaning, coat packing gland threads and valve stems with surface preparation of "Molycote" or "Fel-Pro".
- F. Verify that control valve seats are free of foreign matter and are properly positioned for intended service.
- G. Tighten flanges and other pipe joints after system has been placed in operation. Replace gaskets that show signs of leakage after tightening.
- H. Inspect all joints for leakage:
 - 1. Promptly remake each joint that appears to be faulty; do not wait for rust or other corrosion to form.
 - 2. Clean threads on both parts, and apply compound and remake joints.
- I. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats, and headers in fluid system to ensure freedom from foreign matter.
- J. Open air vents, where used, and remove operating elements. Clean thoroughly, replace internal parts, and place back into operation.
- K. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.

- L. Set and calibrate equipment as required.
- M. Inspect fan wheels for clearance and balance. Provide factory-authorized personnel for adjustment when needed.
- N. Check each electrical control circuit to verify that operation complies with the Contract Documents.
- O. Inspect each pressure gauge, thermometer, and other instruments for calibration. Replace items that are defaced, broken, or that read incorrectly.
- P. Repair damaged insulation.
- Q. Excess Gasses and Fluids:
 - 1. Vent gasses trapped in systems.
 - 2. Verify that liquids are drained from all parts of air systems.

3.3 ATTACHMENTS

- A. The attachment listed below, following the "End of Section" designation, is a part of this Specification Section.
 - 1. Supplier's Installation Certification Form (one page).

+ + END OF SECTION + +

SUPPLIER'S INSTALLATION CERTIFICATION

Contract No. and Name: _____

Equipment Specification Section: _____

Equipment Name: _____

Contractor: _____

Manufacturer of Equipment: _____

The undersigned Supplier of the equipment described above hereby certifies that Supplier has checked the equipment installation and that the equipment, as specified in the Contract Documents, has been provided in accordance with the manufacturer's recommendations and the Contract Documents, and that the trial operation of the equipment has been satisfactory.

Comments: _____

Date

Supplier Name (print)

Signature of Supplier

Date

Contractor Name (print)

Signature of Contractor

SECTION 01 77 19

CLOSEOUT REQUIREMENTS

PART 1 – GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

- A. Definitions: Closeout is defined to include the general requirements near the end of the Contract Time, in preparation for final acceptance, final payment, normal termination of the Contract, occupancy by the OWNER and similar actions evidencing completion of the WORK.

1.2 PREREQUISITES FOR FINAL ACCEPTANCE

- A. General: Prior to requesting the OWNER's final inspection for certifications of final acceptance and final payment, as required by the General Conditions, complete the following and list known exceptions (if any) in request:
 - 1. Submit final payment request with final releases and supports not previously submitted and accepted. Include certificates of insurance for products and completed operations.
 - 2. Submit updated final statement, accounting for additional changes to the Contract Sum.
 - 3. Submit certified copy of the OWNER's final punch-list of itemized WORK to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, endorsed and dated by the OWNER.

1.3 CLOSEOUT PROCEDURES

- A. General Operating/Maintenance Instructions: Arrange for each installer of WORK requiring continuing maintenance (by the OWNER) or operation, to meet with the OWNER's personnel, at the project site, to provide basic instructions needed for proper operation and maintenance of the entire WORK. Include instructions by manufacturer's representatives where installers are not expert in the required procedures. Review maintenance manuals, record documentation, tools, spare parts and materials, identification system, hazards, cleaning and similar procedures and facilities. For operational equipment, demonstrates start-up, shut-down, emergency operations, noise and vibration adjustments, safety, economy/efficiency adjustments, and similar operations. Review maintenance and operations in relation with applicable guarantees, warranties, agreements to maintain, bonds and similar continuing commitments.

1.4 FINAL CLEANING

- A. General: As specified herein, provide final cleaning of the WORK. The following are examples, but not by way of limitation, of the cleaning levels required.
 - 1. Clean project site (yard and grounds), including landscaping, development areas, of litter and foreign substances. Sweep paved areas to a broom-clean condition; remove stains, petrochemical spills and other foreign deposits. Rake grounds, which are neither planted nor paved, to a smooth evenly textured surface.

2. Restore the grass and landscaping to original condition. Repair ruts caused by equipment.
3. Remove discharge piping and restore discharge pipeline trends to original condition. Sod where needed. Mow grass where needed.
4. Remove discharge piping and restore outfall area to original condition.

1.5 REMOVAL OF PROTECTION

- A. Except as otherwise indicated or requested by the OWNER, remove temporary protection devices and facilities which were installed during the course of the WORK to protect previously completed WORK during the remainder of the construction period.

1.6 COMPLIANCY

- A. Comply with safety standards and governing regulations for cleaning operations. Do not burn waste materials at the site, or bury debris or excess materials on the OWNER's property, or discharge volatile or other harmful or dangerous materials into drainage systems; remove waste materials from the site and dispose of in a lawful manner.
- B. Where extra materials of value remaining after completion of the associated WORK have become the OWNER's property, dispose or store at the site as directed by the OWNER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 78 23

OPERATIONS AND MAINTENANCE DATA

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. Submit operation and maintenance data, in accordance with this Section and in accordance with requirements elsewhere in the Contract Documents, as instructional and reference manuals by operations and maintenance personnel at the Site.
2. Required operation and maintenance data are presented in the individual Specification Sections. At minimum, submit operation and maintenance data for:
 - a. All equipment and systems, including manufacturer's operation and maintenance manual.
 - b. Valves, gates, actuators, and related accessories.
 - c. Instrumentation and control devices.
 - d. Electrical gear.
3. For each operation and maintenance manual, submit the following:
 - a. Preliminary Submittal: Electronic copy of entire operation and maintenance manual, except for test data, service reports by Supplier, and electronic copies.
 - b. Final Submittal: Printed and bound copy of complete operations and maintenance manual, including test data and service reports by Supplier, with electronic copies.

B. Quantity Required and Timing of Submittals:

1. Preliminary Submittal:
 - a. Electronic Copies: Two copies, exclusive of any printed copies required by CONTRACTOR.
 - b. Submit to ENGINEER by the earlier of: ninety days following approval of Shop Drawings and product data submittals, or ten days prior to starting training of operations and maintenance personnel, or ten days prior to field quality control testing at the Site.
2. Final Submittal: Provide final submittal prior to Substantial Completion, unless submittal is specified as required prior to an interim Milestone.
 - a. Printed Copies: Three copies.
 - b. Electronic Copies: Three copies.

1.2 FORMAT OF PRINTED COPIES

A. Binding and Cover:

1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be minimum one-inch wide and maximum of three-inch wide. Binders for each copy of each volume shall be identical.
2. Binders shall be locking three-ring/"D"-ring type, or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front of each volume.
3. Do not overfill binders.

4. Covers shall be oil-, moisture-, and wear-resistant, including identifying information on cover and spine of each volume.
 5. Provide the following information on cover of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
 - d. Name of Project and, if applicable, Contract name and number.
 - e. Name of building or structure, as applicable.
 6. Provide the following information on spine of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
 - d. Project name and building or structure name.
- B. Pages:
1. Print pages in manual on 30-pound (minimum) paper, 8.5 inches by 11 inches in size.
 2. Reinforce binding holes in each individual sheet with plastic, cloth, or metal. When published, separately-bound booklets or pamphlets are part of the manual, reinforcing of pages within booklet or pamphlet is not required.
 3. Provide each page with binding margin at least one inch wide. Punch each page with holes suitable for the associated binding.
- C. Drawings:
1. Bind into the manual drawings, diagrams, and illustrations up to and including 11 inches by 17 inches in size, with reinforcing specified for pages.
 2. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and drawing numbers. Include no more than three drawing sheets per pocket.
- D. Copy Quality and Document Clarity:
1. Contents shall be original-quality copies. Documents in the manual shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color. Manuals that contain copies that are unclear, not completely legible, off-center, skewed, or where text or drawings are cut by binding holes, are unacceptable. Pages that contain approval or date stamps, comments, or other markings that cover text or drawing are unacceptable. Faxed copies are unacceptable.
 2. Clearly mark in ink to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished or cross out inapplicable content. Using highlighters to so indicate options furnished is unacceptable.
- E. Organization:
1. Coordinate with ENGINEER and OWNER to develop comprehensive,

practical, and consistent indexing system for operations and maintenance data. ENGINEER will review indexing system before operations and maintenance data is submitted.

2. Table of Contents:
 - a. Provide table of contents in each volume of each operations and maintenance manual.
 - b. In table of contents and at least once in each chapter or section, identify materials and equipment by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is clearly indicated in a table bound at or near beginning of each volume. Using material or equipment model or catalog designations for identification is unacceptable.
3. Use dividers and indexed tabs between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

1.3 FORMAT OF ELECTRONIC COPIES

- A. Electronic Copies of Operation and Maintenance Manuals:
 1. Each electronic copy shall include all information included in the corresponding printed copy.
 2. Submit each electronic copy on a separate compact disc (CD), unless another electronic data transfer method or format is acceptable to ENGINEER.
 3. File Format:
 - a. Files shall be in "portable document format" (PDF). Files shall be electronically searchable.
 - b. Submit separate file for each separate document in the printed copy.
 - c. Within each file, provide bookmarks for the following:
 - 1) Each chapter and subsection listed in the corresponding printed copy document's table of contents.
 - 2) Each figure.
 - 3) Each table.
 - 4) Each appendix.
 4. At the request of the OWNER, also submit drawings and figures in one of the following formats: ".bmp", ".tif", ".jpg", or ".gif". Submit files in a separate directory on the CD.

1.4 CONTENT

- A. General:
 1. Prepare each operations and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-built drawings as applicable, bills of materials, technical bulletins, installation and handling requirements, maintenance and repair instructions, and other information required for complete, accurate, and comprehensive data for safe and proper operation, maintenance, and repair of materials and equipment furnished for the Project. Include in manuals specific information required in the Specification Section for the material or equipment, data required by Laws and Regulations, and data required by authorities having jurisdiction.
 2. Completeness and Accuracy:
 - a. Operation and maintenance manuals that include language stating or implying that the manual's content may be insufficient or stating that

- the manual's content is not guaranteed to be complete and accurate are unacceptable.
- b. Operations and maintenance manuals shall be complete and accurate.
 - c. Operation and maintenance manuals shall indicate the specific alternatives and features furnished, and the specific operation and maintenance provisions for the material or equipment furnished.
3. Submit complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
- B. Submit written explanations of all safety considerations relating to operation and maintenance procedures.
 - C. Submit complete, detailed, written preventive maintenance instructions including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
 1. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Include pre-startup checklists for each equipment item and maintenance requirements for long-term shutdowns.
 2. Recommended schedule for each preventive maintenance task.
 3. Lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
 4. Table of alternative lubricants.
 5. Troubleshooting instructions.
 6. List of required maintenance tools and equipment.
 - D. Submit complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
 1. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 2. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
 3. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
 4. For each part or piece include the following information:
 - a. Parts cross-reference number. Cross-reference number shall be used to identify the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
 - b. Part name or description.
 - c. Manufacturer's part number.
 - d. Quantity of each part used in each assembly.
 - e. Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.

- E. Submit complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.
- F. Submit manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.
- G. Submit manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Avoid submitting catalog excerpts unless they are the only document available showing identification or description of particular component of the equipment. Where materials pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.
- H. Submit original-quality copies of each approved and accepted Shop Drawing, product data, and other submittal, updated to indicate as-installed condition. Reduced drawings are acceptable only if reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.
- I. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
- J. Submit copy of warranty bond and service contract as applicable.
- K. When copyrighted material is used in operations and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. CONTRACTOR shall maintain and submit to ENGINEER with record documents as specified below, except where otherwise specified or modified in Divisions 2 through 46.
- B. Maintenance of Record Documents:
 - 1. Maintain in CONTRACTOR's field office, in clean, dry, legible condition, complete sets of the following record documents: Drawings, Specifications, and Addenda; Shop Drawings, and other CONTRACTOR submittals, including records of test results, approved or accepted as applicable, by ENGINEER; Change Orders, Work Change Directives, Field Orders, photographic documentation, survey data, and all other documents pertinent to the Work.
 - 2. Make record documents available for inspection upon request of ENGINEER or OWNER.
 - 3. Do not use record documents for purpose other than serving as Project record. Do not remove record documents from CONTRACTOR's field office without ENGINEER's approval.
- C. Submittal of Record Documents:
 - 1. Submit to ENGINEER the following record documents:
 - a. Drawings.
 - b. Project Manual including Specifications and Addenda (bound).
 - 2. Prior to readiness for final payment, submit to ENGINEER one copy of final record documents. Submit complete record documents; do not make partial submittals.
 - 3. Submit record documents with transmittal letter on CONTRACTOR letterhead complying with letter of transmittal requirements in Section 01 33 00, Submittal Procedures.
 - 4. Record documents submittal shall include certification, with original signature of official authorized to execute legal agreements on behalf of CONTRACTOR, reading as follows:

"[Insert Contractor's corporate name] has maintained and submitted record documentation in accordance with the General Conditions and Section 01 78 39, Project Record Documents, and other elements of Contract Documents, for the Home Depot Master Lift Station and Forcemain, Sarasota County, Florida. We certify that each record document submitted is complete, accurate, and legible relative to the Work performed under our Contract, and that the record documents comply with the requirements of the Contract Documents.

[Provide signature, print name, print signing party's corporate title, and date]".

1.2 RECORDING CHANGES

A. General:

1. At the start of the Project, label each record document to be submitted as, "PROJECT RECORD" using legible, printed letters. Letters on record copy of the Drawings shall be two inches high.
2. Keep record documents current. Make entries on record documents within two working days of receipt of information required to record the change.
3. Do not permanently conceal the Work until required information has been recorded.
4. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from ENGINEER-accepted record documents.
5. Marking of Entries:
 - a. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to record documents.
 - b. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be legible and sufficiently dark to allow scanning of record documents into legible electronic files.
 - c. Date all entries on record documents.
 - d. Call attention to changes by drawing a "cloud" around the change(s) indicated.
 - e. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

B. Drawings:

1. Record changes on copy of the Drawings. Submittal of CONTRACTOR-originated or -produced drawings as a substitute for recording changes on the Drawings is unacceptable.
2. Record changes on plans, sections, schematics, and details as required for clarity, making reference dimensions and elevations (to Project datum) for complete record documentation.
3. Record actual construction including:
 - a. Depths of various elements of foundation relative to Project datum.
 - b. Horizontal and vertical location of Underground Facilities referenced to permanent surface improvements. For each Underground Facility, including pipe fittings, provide dimensions to at least two permanent, visible surface improvements.
 - c. Location of exposed utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.
 - d. Changes in structural and architectural elements of the Work, including changes in reinforcing.
 - e. Field changes of dimensions, arrangements, and details.
 - f. Changes made in accordance with Change Orders, Work Change Directives, and Field Orders.
 - g. Changes in details on the Drawings. Submit additional details prepared by CONTRACTOR when required to document changes.
4. Recording Changes for Schematic Layouts:
 - a. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical

- arrangement shall be determined by CONTRACTOR subject to acceptance by ENGINEER.
- b. Record on record documents all revisions to schematics on Drawings, including: piping schematics, ducting schematics, process and instrumentation diagrams, control and circuitry diagrams, electrical one-line diagrams, motor control center layouts, and other schematics when included in the Contract. Record actual locations of equipment, lighting fixtures, in-place grounding system, and other pertinent data.
 - c. When dimensioned plans and dimensioned sections on the Drawings show the Work schematically, indicate on the record documents, by dimensions accurate to within one inch in the field, centerline location of items of Work such as conduit, piping, ducts, and similar items
 - 1) Clearly identify the Work item by accurate notations such as "cast iron drain", "rigid electrical conduit", "copper waterline", and similar descriptions.
 - 2) Show by symbol or note the vertical location of Work item; for example, "embedded in slab", "under slab", "in ceiling plenum", "exposed", and similar designations. For piping not embedded, also provide elevation dimension relative to Project datum.
 - 3) Descriptions shall be sufficiently detailed to be related to Specifications.
 - d. ENGINEER may furnish written waiver of requirements relative to schematic layouts shown on plans and sections when, in ENGINEER's judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on waiver(s) being issued.
5. Supplemental Drawings:
- a. In some cases, drawings produced during construction by ENGINEER or CONTRACTOR supplement the Drawings and shall be included with record documents submitted by CONTRACTOR. Supplemental record drawings shall include drawings provided with Change Orders, Work Change Directives, and Field Orders and that cannot be incorporated into the Drawings due to space limitations.
 - b. Supplemental drawings provided with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.
 - c. When supplemental drawings developed by CONTRACTOR using computer-aided drafting/design (CADD) software are to be included in record drawings, submit electronic files for such drawings in AutoCAD as part of record drawing submittal. Submit electronic files on compact disc labeled, "Supplemental Record Drawings", together with CONTRACTOR name, Project name, and Contract name and number.
- C. Specifications and Addenda:
- 1. Mark each Section to record:
 - a. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually provided.
 - b. Changes made by Addendum, Change Orders, Work Change Directives, and Field Orders.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 78 43

SPARE PARTS AND EXTRA MATERIALS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. CONTRACTOR shall furnish spare parts data and extra materials for materials and equipment in accordance with the Contract Documents.
- B. List of Spare Parts and Extra Materials: With the Shop Drawings and product data for each Specification Section, submit a complete list of spare parts, extra stock materials, maintenance supplies, and special tools required for maintenance ("spare parts and extra materials") for two years of operation, with unit prices in current United States funds, and source(s) of supply for each.
- C. Packaging and Labeling: Furnish spare parts and extra materials in manufacturer's unopened cartons, boxes, crates, or other original, protective covering suitable for preventing corrosion and deterioration for maximum length of storage normally anticipated by manufacturer. Packaging of spare parts and extra materials shall be clearly marked and identified with name of manufacturer, applicable equipment, part number, part description, and part location in the equipment. Protect and package spare parts and extra materials for maximum shelf life normally anticipated by manufacturer.
- D. Storage Prior to Delivery to Owner: Prior to furnishing spare parts and extra materials to OWNER, store spare parts and extra materials in accordance with the Contract Documents and manufacturers' recommendations.
- E. Delivery Time and Eligibility for Payment:
 - 1. Deliver to OWNER spare parts and extra materials upon Substantial Completion for equipment or system associated with the spare parts and extra materials. Do not deliver spare parts and extra materials before commencing start-up for associated equipment or system.
 - 2. Spare parts and extra materials are not eligible for payment until delivered to OWNER and CONTRACTOR's receipt of OWNER's countersignature on letter of transmittal.
- F. Procedure for Delivery to Owner: Deliver spare parts and extra materials to OWNER's storage room at the Site at a Site designated by OWNER. When spare parts and extra materials are delivered, CONTRACTOR and ENGINEER will mutually inventory the spare parts and extra materials delivered to verify compliance with the Contract Documents regarding quantity and part numbers. Additional procedures for delivering spare parts and extra materials to OWNER, if required, will be developed by ENGINEER and complied with by CONTRACTOR.
- G. Transfer Documentation:
 - 1. Furnish on CONTRACTOR letterhead a letter of transmittal for spare parts and extra materials furnished under each Specification Section. Letter of transmittal shall accompany spare parts and extra materials. Do not furnish letter of transmittal separate from associated spare parts and extra materials.

2. Furnish an original signed letter of transmittal for each Specification Section. Upon delivery of specified quantities and types of spare parts and extra materials to OWNER, designated person from OWNER will countersign each original letter of transmittal indicating OWNER's receipt of spare parts and extra materials.
 3. Letter of transmittal shall include the following:
 - a. Information required for letters of transmittal in Section 01 33 00, Submittal Procedures.
 - b. Transmittal shall list spare parts and extra materials furnished under each Specification Section. List each individual part or product and quantity furnished.
 - c. Provide space for countersignature by OWNER as follows: space for signature, space for printed name, and date.
- H. CONTRACTOR shall be fully responsible for loss or damage to spare parts and extra materials until spare parts and extra materials are received by OWNER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 79 13

SYSTEM AND FACILITY PERFORMANCE TESTING PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, services, equipment, and incidentals required for performance testing as indicated in the Contract Documents.
2. Conduct performance testing for each item of process; mechanical; instrumentation and control; plumbing; heating, ventilating, and air conditioning (HVAC); electrical systems and equipment; and other systems and equipment; as listed in Table 01 79 13-A of this Section, to demonstrate compliance with the performance requirements of the Contract Documents.
- 3 Objectives of performance testing are to:
 - a. Demonstrate to satisfaction of OWNER and ENGINEER that structures, systems, and equipment tested comply with all functional and performance requirements in the Contract Documents.
 - b. Demonstrate that facility is Substantially Complete
 - c. Establish baseline operating conditions for OWNER's use in establishing standard operating procedures and preventative maintenance programs.
4. Utilities and Consumables:
 - a. CONTRACTOR shall provide the following: electricity, fuel, compressed air, chemicals, temporary piping and appurtenances, and all other items and Work required for completing performance testing.
 - b. OWNER will provide the following: water for initial performance testing. CONTRACTOR shall provide temporary piping and appurtenances required to convey to the testing location utilities and consumables furnished by OWNER. If re-testing is required, cost of utilities and consumables furnished by OWNER for initial testing shall be paid by CONTRACTOR at OWNER's cost or standard rates, as applicable.
5. Sequence: The following general sequence applies to performance testing:
 - a. Furnish submittals required prior to performance testing, in accordance with this Section.
 - b. Complete the Work associated with starting and placing equipment in operation.
 - c. To the extent practicable, complete Site quality control Work specified in Specification Sections for individual equipment items and systems.
 - d. Proceed with performance testing in accordance with this Section, simulating the range of actual operating conditions to the greatest extent possible.
 - e. Successful completion of performance testing is required to achieve Substantial Completion.

B. Coordination:

1. Review procedures under this and other Sections and coordinate installation and testing of items that must be started up and tested with or before performance testing Work.
2. Notify other contractors in advance of performance testing Work to provide them with sufficient time for installing and testing items included in their contracts that must be installed and tested with or before performance testing Work.

1.2 TERMINOLOGY

- A. The following words or terms are not defined but, when used in this Section, have the following meaning:
 1. A "system" includes all required items of equipment, devices, and appurtenances connected so that their operation or function complements, protects, or controls the operation or function of the others.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 1. Contractor's Performance Testing Manager (may be Contractor):
 - a. Appoint a performance testing manager, who shall:
 - 1) Manage, coordinate, and supervise CONTRACTOR's performance testing.
 - 2) Assist in coordinating and documenting Site quality control Work specified in individual Specifications Sections.
 - 3) Prepare, or review and approve, all submittals for the Work under this Section
 - 4) Coordinate activities of Subcontractors and Suppliers relative to performance testing.
 - 5) Make frequent visits to the Site during performance testing.
 - b. Experience:
 - 1) Performance testing manager shall have at least five years of experience in work similar to that required, or experience on at least five separate projects, in managing performance testing of process, mechanical, instrumentation and control, HVAC, and electrical systems.
- B. Pre-performance Testing Conference:
 1. After initial submittal of documentation plan and performance testing plan and prior to starting performance testing, arrange a meeting at Site with CONTRACTOR's performance testing manager, CONTRACTOR's other key personnel, equipment Suppliers' technical representatives, authority having jurisdiction over operating permit(s), ENGINEER, OWNER, and other representatives directly concerned with performance testing Work. Record discussions of conference and decisions and agreements and disagreements and furnish a copy of record to each party attending. Review foreseeable methods and procedures relating to performance testing Work including:
 - a. Review Project requirements including Contract Documents, submittals related to performance testing, requests for interpretations relative to performance testing, and other pertinent documents.
 - b. Review required submittals, both completed and to be completed.

- c. Review status of the equipment and systems to be performance tested and work to be completed prior to performance testing.
- d. Review Progress Schedule and testing schedule.
- e. Review status of utilities and consumables required for performance testing.
- f. Review required inspections, testing, certifying, and quality control procedures.
- g. Review methods for complying with Laws and Regulations and requirements of authorities having jurisdiction, such as compliance with facility operating permit requirements, insurance requirements, environmental protection, health, safety, fire, and similar regulations.
- 2. Reconvene meeting at earliest opportunity if additional information must be developed to conclude the required topics of the meeting.
- 3. Record revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Documentation plan, in accordance with Article 1.5 of this Section.
 - 2. Performance testing plans, in accordance with Article 1.5 of this Section.
- B. Informational Submittals: Submit the following:
 - 1. Records of pre-performance testing conference.
 - 2. Testing schedules, in accordance with Article 1.5 of this Section.
 - 3. Notices: Written notice to ENGINEER and OWNER at least 72 hours prior to beginning each test.
 - 4. Site Quality Control Submittals: All records produced during, and results of, performance testing.
 - 5. Qualifications Statements:
 - a. Testing laboratory qualifications and certifications, if not previously submitted under other Sections.
 - b. Qualifications of CONTRACTOR's performance testing manager and other required performance testing personnel, including copies of valid operators' licenses issued by authority having jurisdiction.

1.5 DOCUMENTATION PLAN, PERFORMANCE TESTING PLAN, AND TESTING SCHEDULE

- A. Documentation Plans: Develop recordkeeping system to document compliance with requirements of this Section and authorities having jurisdiction.
 - 1. Calibration documentation including identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, date(s) of subsequent calibrations, calibration method, and test laboratory verifying calibration.
 - 2. Documentation to be provided for each equipment item and system to be tested shall include date of test, equipment tag number or system name, nature of test, test objectives, test results, test instruments employed, and signature spaces for CONTRACTOR's performance testing manager and OWNER's and ENGINEER's witnesses. Establish separate file for each system and equipment item to be tested. Files shall include the following

information, as applicable, when associated tests, source quality control, or Site quality control measures are required in the Contract Documents:

- a. Metallurgical tests, when required.
- b. Source quality control (factory) tests.
- c. Accelerometer recordings made during shipment, when such recordings are required.
- d. Field calibration tests, in accordance with the Contract Documents.
- e. Field hydrostatic tests for equipment and systems that operate under pressure, in accordance with the Contract Documents.
- f. Site quality control testing, in accordance with the Contract Documents

3. Forms:

- a. Develop forms specific to each item of equipment and system being tested, to document results of testing.
- b. Provide forms approved by ENGINEER in sufficient quantity to document all testing Work.

B. Performance Testing Plans:

1. Develop performance testing plans describing in detail coordinated, sequential performance testing of each system and equipment item to be tested. Each performance testing plan shall be specific to the system or equipment item to be performance-tested, and shall identify by specific equipment or tag number each device or control station to be manipulated or observed during performance testing, and specific results to be observed or obtained. Performance testing plans shall also be specific regarding support systems required to complete the performance testing Work, temporary devices and systems required (if any) during performance testing, Subcontractors and Suppliers to be present during performance testing, and planned performance testing duration. Performance testing plans shall include:
 - a. Summary of start-up, check-out, and Site quality control testing required for each system or equipment item prior to starting performance testing.
 - b. Calibration of all field instruments and control devices.
 - c. Description of and information on temporary systems, equipment, and devices proposed for performance testing, including calibration data for temporary instrumentation and controls.
 - d. Plan and procedures for implementing performance testing of systems and equipment. Performance tests shall duplicate the operating conditions described in the Contract Documents.
 - e. Description of data reduction required, if any, and proposed time between collection of data and submittal of results to ENGINEER.
 - f. Summary of criteria for acceptance of test results. Summary shall include performance tolerances (if any) included in the Contract Documents. Where performance tolerances are not included in the Contract Documents, testing plan shall include proposed performance tolerances.
2. Performance testing plans shall contain complete description of proposed procedures to achieve desired testing environment.
3. Following ENGINEER's approval of performance testing plans, CONTRACTOR shall reproduce performance testing plans in sufficient quantity for CONTRACTOR'S purposes plus five copies to ENGINEER and

five copies to OWNER. Do not start performance testing until required quantity of approved performance testing plans is provided.

C. Testing Schedule:

1. Provide a testing schedule that sets forth the planned sequence for performance testing Work.
2. Testing schedule shall be part of the Progress Schedule and shall conform to requirements for Progress Schedule, except as specified in this Section.
3. Test schedule shall:
 - a. Detail the equipment and systems to be performance-tested, and the testing duration required for each.
 - b. Show planned start date, duration, and completion of each performance test.
 - c. Submitted no later than four weeks in advance of the date performance testing is to begin. ENGINEER will not witness performance testing Work until test schedule is accepted by ENGINEER.
 - d. Be updated weekly and resubmitted to ENGINEER. Updates shall indicate actual dates of performance testing Work, indicating systems and equipment for which performance testing is in progress, and that are satisfactorily completed in accordance with the Contract Documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

- A. Before starting the performance testing, complete the following:
1. Prepare and align equipment in accordance with equipment Specifications.
 2. To the extent practicable, complete equipment tests and check-out in accordance with the Contract Documents and manufacturers' recommendations.
 3. Complete other tests required by the Contract Documents, including instrumentation and controls calibration and testing, piping tests, electrical tests, and other tests required prior to full operation of the system or facility.
 4. Complete the Work required in Section 01 75 11, Checkout and Startup Procedures.
- B. Temporary Systems and Devices Required for Performance Testing:
1. Minimize the need for temporary systems and devices required for performance testing.
 2. Provide temporary connections and bulkheads as required, and make other provisions to re-circulate process fluids and gasses as required or otherwise simulate the range of anticipated operating conditions for the systems and equipment being performance-tested. During performance testing, CONTRACTOR's performance testing manager and team shall monitor the characteristics of each equipment item and system and report unusual conditions to ENGINEER.

3. Properly install temporary systems. Test temporary equipment and devices in accordance with manufacturer's instructions to verify suitability for use in performance testing. Test temporary piping using in accordance with requirements for associated permanent piping.
4. Calibration and Loop Testing of Temporary Instruments and Controls: Calibrate and test all loops and associated instruments and control devices, in accordance with instrumentation and controls Sections of Division 40, Process Integration.

3.2 PERFORMANCE TESTING

- A. CONTRACTOR's performance testing manager shall organize teams comprising qualified representatives of Suppliers, Subcontractors, CONTRACTOR's independent testing laboratory (if applicable), and others as appropriate, to efficiently and complete performance testing Work within the Contract Times and in accordance with the accepted Progress Schedule.
- B. Performance testing shall be done in accordance with the approved performance testing plan, approved documentation plan, and accepted testing schedule. Performance-test the systems and equipment items listed in Table 01 79 13-A of this Section.
- C. System Performance Tests:
 1. Testing:
 - a. Duration:
 - 1) Operate and performance-test the system (or each portion thereof, as applicable) and equipment for sufficient period of time to determine: operating characteristics of system and equipment, including noise, temperatures, and vibration; observe its performance characteristics; and for initial adjustment of controls and appurtenances.
 - 2) The minimum duration of performance testing for each system or equipment item shall be the number of continuous and consecutive days specified in Table 01 79 13-A in this Section. List the proposed performance testing duration in the testing plan and testing schedule.
 - 3) Duration of performance testing shall be in accordance with the approved testing plan and accepted testing schedule.
 - b. When testing requires availability of temporary systems such as temporarily "looped" piping, temporary or standby electrical power, temporary compressed air, or temporary instrumentation and controls, provide acceptable alternate sources that meet the requirements of system and equipment being tested.
 - c. Disposal site for test media that have the potential, upon disposal, to create a Hazardous Environmental Condition, are subject to review and acceptance by OWNER and ENGINEER.
 - d. During performance testing, CONTRACTOR shall obtain baseline operating data on equipment with motors greater than one horsepower. Baseline data shall include amperage, bearing temperatures, and vibration data obtained at intervals in the approved testing plan. Methods of measurement shall be in

accordance with industry standards applicable for the motors being tested.

2. Test Interruption: Should testing be halted for any reason, repeat the operational testing until specified continuous testing period is completed for the system or equipment item without interruption, in accordance with the Contract Documents.
3. Test Results and Re-testing: The following applies to the entire system tested and to portions thereof:
 - a. Successful test results shall indicate conformance in accordance with the Contract Documents. If performance tolerances are not specified in the Contract Documents, test results shall conform to tolerances established in approved testing plan submittal.
 - b. When results of performance testing fail to comply with the Contract Documents regarding such test, CONTRACTOR shall make adjustments and repairs as required and shall repeat the tests as required until conform with the Contract Documents is achieved.
 - c. Re-testing Because of Disputed Testing Results or Procedures: In the case of an otherwise satisfactory performance test, when there is doubt, dispute, or difference between ENGINEER and CONTRACTOR regarding testing results, methods, or equipment used in performance testing, ENGINEER may order CONTRACTOR to repeat the testing. If repeat testing using such modified methods or equipment required by ENGINEER confirms the previous test, all costs of repeat test will be paid by OWNER. Otherwise all costs, including costs of engineering, labor, testing agencies, and inspections, shall be paid by CONTRACTOR.

3.3 REQUIRED PERFORMANCE TESTING

- A. The schedules listed below, following the "End of Section" designation, are a part of this Specification Section.
 1. Table 01 79 13-A, Required Performance Testing.

+ + END OF SECTION + +

TABLE 01 79 13-A, REQUIRED PERFORMANCE TESTING

Name of System or Principal Equipment to be Performance-Tested	Appurtenant or Associated Systems or Equipment ⁽¹⁾	Performance Testing Minimum Duration (days)	Systems or Equipment to be Tested Concurrently with this System ⁽²⁾	Remarks
1. Lift Station	Submersible pumps, Conditioning pump, Electrical systems, Instrumentation	15	-	
2. Diesel Back up Pump	-	1	-	

Notes:

- (1) The appurtenant or associated systems or equipment listed in this column may not completely name all systems or equipment associated with the operation of the principal system or equipment being tested. Performance-test all appurtenant systems and equipment associated with the principal system or equipment, when the appurtenant system or equipment is required for operation of the principal system or equipment being performance tested.
- (2) Performance-test all appurtenant systems and equipment associated with the principal system or equipment being performance-tested. And the additional systems or equipment listed in this column.

SECTION 01 79 23

INSTRUCTION OF OPERATIONS AND MAINTENANCE PERSONNEL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall furnish services of Manufacturer's operation and maintenance training specialists to instruct OWNER's personnel in recommended operation and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.
2. Manufacturer shall provide field training at the Site, unless otherwise required elsewhere in the Contract Documents.
3. OWNER reserves the right to record training sessions on video for OWNER's later use in instructing OWNER's personnel.
4. All materials shall be submitted to the Engineer in PDF format for review and approved at least 60 days prior to scheduled training.

B. Scheduling of Training Sessions:

1. General:
 - a. CONTRACTOR shall coordinate training services with start-up and initial operation of materials and equipment on days and times, and in manner, acceptable to OWNER, in accordance with the Contract Documents.
 - b. Training may be required outside of normal business hours to accommodate schedules of operations and maintenance personnel. Furnish training services at the required days and times at no additional cost to OWNER.
2. Prerequisites to Training:
 - a. Training of OWNER'S personnel shall commence after acceptable preliminary operation and maintenance data has been submitted and work required in Section 01 75 11, Checkout and Startup Procedures, and Section 01 79 13, Equipment and System Startup and Performance Testing Procedures is complete.
 - b. At option of OWNER or ENGINEER, training may be allowed to take place before, during, or after equipment start-up.
3. Training Schedule Submittal:
 - a. Training Schedule Required: CONTRACTOR shall prepare and submit proposed training schedule for review and acceptance by ENGINEER and OWNER. Proposed training schedule shall show all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training, number of training sessions, and scheduling.
 - b. Timing of Training Schedule Submittal: Submit initial training schedule at least thirty days before scheduled start of first training session. Submit final training schedule, incorporating revisions in accordance with ENGINEER's comments, no later than fourteen days prior to starting the first training session.
 - c. OWNER reserves the right to modify personnel availability for training in accordance with process or emergency needs at the Site.

1.2 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer's instructors shall be factory-trained by manufacturer of material or equipment.
 - 2. Manufacturer's instructors shall be proficient and experienced in conducting training of type required.
 - 3. Qualifications of instructors are subject to acceptance by ENGINEER. If ENGINEER does not accept qualifications of proposed instructor, furnish services of replacement instructor with acceptable qualifications.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule submittals in accordance with time frames specified in this Section.
- B. Informational Submittals: Submit the following:
 - 1. Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with the Contract Documents. Lesson plan shall comply with requirements of this Section. Include with lesson plan copy of handouts that will be used during training sessions. Provide lesson plan submittals in accordance with time frames specified in this Section.
 - 2. Qualifications: Credentials of manufacturer's proposed operations and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Section and shall include brief resume' and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.
- C. Closeout Submittals: Submit the following:
 - 1. Trainee sign-in sheet for each training session. Submit to OWNER.

1.4 LESSON PLAN

- A. Supplier's lesson plan shall describe specific instruction topics, system components for which training will be furnished, and training procedures. Handouts, if any, to be used in training shall be included with the lesson plan. Describe in lesson plan "hands-on" demonstrations planned for training sessions.
- B. Submit acceptable lesson plan seven days prior to starting associated training.
- C. Lesson plan shall include estimated duration of each training segment.
- D. Lesson plan shall include the following:
 - 1. Equipment Overview (required for all types of operations and maintenance training):
 - a. Describe equipment's operating (process) function and performance objectives.

- b. Describe equipment's fundamental operating principles and dynamics.
- c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
- d. Identify all support equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
- e. Identify and describe safety precautions and potential hazards related to operation.
- f. Identify and describe in detail safety and control interlocks.
- 2. Operations Personnel Training:
 - a. Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.
 - b. Operation:
 - 1) Describe operating principles and practices.
 - 2) Describe routine operating, start-up, and shutdown procedures.
 - 3) Describe abnormal or emergency start-up, operating, and shutdown procedures that may apply.
 - 4) Describe alarm conditions and responses to alarms.
 - 5) Describe routine monitoring and recordkeeping procedures.
 - 6) Describe recommended housekeeping procedures.
 - c. Troubleshooting:
 - 1) Describe how to determine if corrective maintenance or an operating parameter adjustment is required.
- 3. Mechanical Maintenance Training:
 - a. Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.
 - b. Equipment Preventive Maintenance:
 - 1) Describe preventative maintenance inspection procedures required to:
 - a) Inspect equipment in operation.
 - b) Identify potential trouble symptoms and anticipate breakdowns.
 - c) Forecast maintenance requirements (predictive maintenance).
 - 2) Define recommended preventative maintenance intervals for each component.
 - 3) Describe lubricant and replacement part recommendations and limitations.
 - 4) Describe appropriate cleaning practices and recommend intervals.
 - 5) Identify and describe use of special tools required for maintenance of equipment.
 - 6) Describe component removal, installation, and disassembly and assembly procedures.
 - 7) Perform "hands-on" demonstrations of preventive maintenance procedures.
 - 8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

- 9) Define recommended torquing, mounting, calibrating, and aligning procedures and settings, as appropriate.
- 10) Describe recommended procedures to check and test equipment following corrective maintenance.
- c. Equipment Troubleshooting:
 - 1) Define recommended systematic troubleshooting procedures.
 - 2) Provide component-specific troubleshooting checklists.
 - 3) Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.
 - 4) Describe common corrective maintenance procedures with "hands on" demonstrations.
4. Instrumentation/Controls Maintenance Training:
 - a. Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.

1.5 TRAINING AIDS

- A. Manufacturer's instructor shall incorporate training aids as appropriate to assist in the instruction. Provide handouts of text, tables, graphs, and illustrations as required. Other appropriate training aids include:
 1. Audio-visual aids, such as videos, Microsoft Powerpoint presentations, overhead transparencies, posters, drawings, diagrams, catalog sheets, or other items.
 2. Equipment cutaways and samples, such as spare parts and damaged equipment.
 3. Tools, such as repair tools, customized tools, and measuring and calibrating instruments.
- B. Handouts:
 1. Manufacturer's instructor shall distribute and use descriptive handouts during training. Customized handouts developed especially for training for the Project are encouraged.
 2. Photocopied handouts shall be good quality and completely legible.
 3. Handouts should be coordinated with the instruction, with frequent references made to the handouts.
 4. Provide at least five copies of handouts for each training session.
- C. Audio-visual Equipment: Training provider shall provide audio-visual equipment required for training sessions. OWNER is not responsible for providing audio-visual equipment. Audio-visual equipment that training provider shall provide, as required, includes:
 1. Laptop computer, presentation software, and suitable projector.
 2. As required, extension cords and spare bulb for projector.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 02 41 00

DEMOLITION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required for demolition, removal, and disposal Work.
2. The Work under this Section includes, but is not necessarily limited to:
 - a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of structural concrete, foundations, walls, doors, windows, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical systems and equipment, paving, curbs, sidewalks, gutters, fencing and similar existing facilities.
 - b. Demolition and removal of all Underground Facilities underneath, and above-grade piping and utilities in, the building(s) and structures shown or indicated for demolition, unless the Underground Facilities or above-grade facilities are shown or indicated as to remain.
 - c. Remove from slabs, foundations, walls, and footings that are to be demolished all utilities and appurtenances embedded in such construction.
3. Demolitions and removals specified under other Sections shall comply with requirements of this Section.
4. Perform demolition Work within areas shown or indicated.
5. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition.

B. Coordination:

1. Comply with Section 01 14 16, Coordination with Owner's Operations.
2. Review procedures under this and other Sections and coordinate the Work that will be performed with or before demolition and removals.

C. Related Sections:

1. Section 31 11 00, Clearing and Grubbing.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician legally qualified to perform electrical construction and electrical work in the jurisdiction where the Site is located.
2. Plumbing Removals: Entity and personnel performing plumbing removals shall be plumber legally qualified to perform plumbing construction and plumbing work in the jurisdiction where the Site is located.

B. Regulatory Requirements:

1. Demolition, removal, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T - Demolition), and all other Laws and Regulations.

2. Comply with requirements of authorities having jurisdiction.

1.3 SUBMITTALS

- A. Informational Submittals: Submit the following:
 1. Procedure Submittals:
 - a. Demolition and Removal Plan: Not less than ten days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:
 - 1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.
 - 2) Other proposed procedures as applicable.
 - 3) Equipment proposed for use in demolition operations.
 - 4) Recycling/disposal facility(ies) proposed, including facility owner, facility name, location, and processes. Include copy of appropriate permits and licenses, and compliance status.
 - 5) Planned demolition operating sequences.
 - 6) Detailed schedule of demolition Work in accordance with the accepted Process Schedule.
 2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

- A. Notification:
 1. At least 48 hours prior to commencing demolition or removal, notify ENGINEER in writing of planned start of demolition Work. Do not start removals without permission of ENGINEER.
- B. Protection of Surrounding Areas and Facilities:
 1. Perform demolition and removal Work in manner that prevents damage and injury to property, structures, occupants, the public, and facilities. Do not interfere with use of, and free and safe access to and from, structures and properties.
 2. Closing or obstructing of roads, drives, sidewalks, and passageways adjacent to the Work is not allowed unless indicated otherwise in the Contract Documents. Conduct the Work with minimum interference to vehicular and pedestrian traffic.
 3. Provide temporary barriers, lighting, sidewalk sheds, and other necessary protection.
 4. Repair damage to facilities that are to remain.
- C. Existing Utilities: In addition to requirements of the General Conditions, and Division 01 Specifications, do the following:
 1. Should uncharted or incorrectly charted Underground Facilities be encountered, CONTRACTOR responsibilities shall be in accordance with the General Conditions. Cooperate with utility owners in keeping adjacent services and facilities in operation.

2. Sanitary Sewer: Before proceeding with demolition, locate and cap all sewer lines and service laterals discharging from the building or structure being demolished.
3. Water Piping: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished.
4. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.
5. Shutdown of utility services shall be coordinated by CONTRACTOR, assisted by OWNER as required relative to contacting utility owners.

3.2 DEMOLITION – GENERAL

- A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.
- B. Pollution Controls:
 1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level. Comply with Section 01 57 05, Temporary Controls, and Laws and Regulations.
 2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.
 3. Clean adjacent structures, facilities, properties, and improvements of dust, dirt, and debris caused by demolition Work, in accordance with the General Conditions.
- C. Explosives:
 1. Use of explosives is prohibited.
- D. Building or Structure Demolition:
 1. Unless otherwise approved by ENGINEER, proceed with demolition from top of building or structure to the ground. Complete demolition Work above each floor or tier before disturbing supporting members of lower levels.
 2. Demolish concrete and masonry in small sections.
 3. Remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.
 4. Break up and remove foundations and slabs-on-grade unless otherwise shown or indicated as remaining in place.
- E. Demolition of Site Improvements:
 1. Pavement, Sidewalks, Curbs, and Gutters: Demolition of asphalt or concrete pavement, sidewalks, curbs, and gutters, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.
 2. Fencing, Guardrails, and Bollards: Remove to the limits shown or indicated on the Drawings. Completely remove below-grade posts and concrete.
 3. Manholes, Vaults, Chambers, and Handholes: Remove to the limits shown or indicated on the Drawings.
 4. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes: Remove to the extent shown or indicated on the Drawings. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Section.

5. Landscaping: Comply with Section 31 11 00, Clearing and Grubbing.
- F. Salvage and Ownership:
 1. Refer to Section 01 11 13, Summary of Work, for requirements on salvage, ownership, and handling of equipment and materials removed during demolition and removal Work.
 2. Materials and equipment to remain OWNER's property shall be carefully removed and appropriately handled by CONTRACTOR to avoid damage and invalidation of warranties in effect, and shall be cleaned and stored at the Site (or other site specified in the Contract Documents) at place designated by ENGINEER or OWNER.

3.3 STRUCTURAL REMOVALS

- A. Remove structures to lines and grades shown or indicated, unless otherwise directed by ENGINEER. Where limits are not shown or indicated, limits shall be four inches outside item to be installed. Removals beyond limits shown or indicated shall be at CONTRACTOR's expense and such excess removals shall be reconstructed to satisfaction of ENGINEER without additional cost to OWNER.
- B. Recycling and Reuse of Demolition Materials:
 1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, unless otherwise approved by ENGINEER.
 2. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.
- C. After removing concrete and masonry walls or portions thereof, slabs, and similar construction that ties in to the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.
- D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.
 1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.
 2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.
 3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 inches below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.
 4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.

- E. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, remove the anchors to not less than 1.5 inches beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by ENGINEER.
- F. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.
- G. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials under this Section, unless specified elsewhere in the Contract Documents.

3.4 MECHANICAL REMOVALS

- A. Mechanical demolition and removal Work includes dismantling and removing existing piping, ductwork, pumps, equipment, tanks, and appurtenances as shown, indicated, and required for completion of the Work. Mechanical removals include cutting and capping as required.
- B. Demolition and Removals of Piping, Ductwork, and Similar Items:
 - 1. Purge piping and tanks (as applicable) of chemicals or fuel (as applicable) and make safe for removal and capping. Remove to the extent shown or indicated existing process, water, waste and vent, chemical, gas, fuel, and other piping. Remove piping to the nearest solid piping support, and provide caps on ends of remaining piping.
 - 2. Caps, Closures, Blind Flanges, and Plugs:
 - a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.
 - b. Where used in this Section, the term "cap" means the appropriate type closure for the piping or ductwork being closed, including caps, blind flanges, and other closures.
 - c. Caps shall be compatible with the piping or ductwork to which the cap is attached, fluid-tight and gastight, and appropriate for the fluid or gas conveyed in the pipe or duct.
 - d. Unless otherwise shown or indicated, caps shall be mechanically fastened, fused, or welded to pipe or duct. Plug piping with means other than specified in this Section only when so shown or indicated in the Contractor Documents or when allowed by ENGINEER.
 - 3. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.
 - 4. Remove waste and vent piping, and ductwork to extent shown and cap as required. Where demolished vent piping, stacks, and ductwork passes through existing roofing, patch the roof with the same or similar materials. Completed patch shall be watertight and comply with roofing manufacturer's recommendations.
 - 5. Modifications to potable water piping and other plumbing and heating system work shall comply with Laws and Regulations. All portions of potable water system that have been modified or opened shall be

hydrostatically tested and disinfected in accordance with the Contract Documents, and Laws and Regulations. Hydrostatically test other, normally-pressurized, plumbing piping and heating piping.

C. Equipment Demolition and Removals:

1. To the extent shown or indicated, remove existing process equipment; pumps; storage tanks; hoisting and conveying equipment; heating, ventilating, and air conditioning equipment; generators; and other equipment.
2. Where required, disassemble equipment to avoid imposing excessive loading on supporting walls, floors, framing, facilities, and Underground Facilities. Disassemble equipment as required for access through and egress from building or structure. Disassembly shall comply with Laws and Regulations. Provide required means to remove equipment from building or structure.
3. Remove control panels, operator stations, and instruments associated with equipment being removed, unless shown or indicated otherwise.
4. Remove fuel appurtenances as applicable, including fuel storage tanks. Dispose of tank contents in accordance with Laws and Regulations.
5. Remove equipment supports as applicable, anchorages, base, grout, and piping. Remove anchorage systems in accordance with the "Structural Removals" Article in this Section. Remove small-diameter piping back to header unless otherwise indicated.
6. Remove access platforms, ladders, and stairs related to equipment being removed, unless otherwise shown or indicated.

3.5 ELECTRICAL REMOVALS

- A. Electrical demolition Work includes removing existing transformers, distribution switchboards, control panels, motors, starters, conduit and raceways, cabling, poles and overhead cabling, panelboards, lighting fixtures, switches, and miscellaneous electrical equipment, as shown, specified, or required.
- B. Remove existing electrical equipment and fixtures to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
- C. Remove or modify motor control centers and switchgear as shown or indicated. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.
- D. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated. Motors, microprocessors and electronics, other electrical gear to be reused shall be stored in accordance with Section 01 66 00, Product Storage and Handling Requirements.
- E. Cables in conduits to be removed shall be removed back to the power source or control panel, unless otherwise shown or indicated. Verify the function of each cable before disconnecting and removing.
- F. Conduits, raceways, and cabling shall be removed where shown or indicated. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and

the area repaired in a flush, smooth manner acceptable to ENGINEER. Exposed conduits, junction boxes, other electrical appurtenances, and their supports shall be disassembled and removed. Repair all areas of the Work to prevent rusting on exposed surfaces.

- G. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.
- H. Where shown or indicated, remove direct burial cable. Openings in buildings for entrance of direct burial cable shall be patched with repair mortar or other material approved by ENGINEER for this purpose, and made watertight.
- I. Existing poles and overhead cables shall be removed or abandoned as shown and specified. Existing substation(s) and poles owned by electric utility will be removed by the electric utility. Completely remove from the Site poles not owned by electric utility and shown or indicated for removal. Make necessary arrangements with electric utility for removal of utility company's transformers and metering equipment after new electrical system has been installed and energized.
- J. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as OWNER's property, shall be removed and properly disposed off-Site as required.

3.6 DISPOSAL OF DEMOLITION DEBRIS

- A. Remove from the Site all debris, waste, rubbish, and material resulting from demolition operations and equipment used in demolition Work. Comply with the General Conditions, and Section 01 74 05, Cleaning.
- B. Transportation and Disposal:
 - 1. Non-hazardous Material: Properly transport and dispose of non-hazardous demolition debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Asbestos, PCBs, Petroleum, Hazardous Waste, Radioactive Material, or other material designated as hazardous in Laws and Regulations.
 - 2. Hazardous Material: When handling and disposal of hazardous materials is included in the Work, properly transport and dispose of hazardous materials in accordance with the Contract Documents and Laws and Regulations.
- C. Submit to ENGINEER information required in this Section on proposed facility(ies) where demolition material will be recycled. Upon request, ENGINEER or OWNER, shall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist ENGINEER and OWNER.

+ + END OF SECTION + +

SECTION 03 00 05

CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete, reinforcing, and related materials.
2. The Work includes:
 - a. Providing concrete consisting of portland cement, fine and coarse aggregates, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured.
 - b. Fabricating and placing reinforcing, including ties and supports.
 - c. Design, erection, and removal of formwork.
 - d. Building into the concrete all sleeves, frames, anchorage devices, inserts, and other items required to be embedded in concrete.
 - e. Providing openings in concrete as required to accommodate Work under this and other Sections.

B. Coordination:

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

C. Classifications of Concrete:

1. Class "A" concrete shall be steel-reinforced and includes all Cast-in-place concrete unless otherwise shown or indicated.
2. Class "B" concrete shall be placed without forms or with simple forms, with little or no reinforcing and includes the following:
 - a. Concrete fill.
 - b. Duct banks.
 - c. Unreinforced encasements.
 - d. Curbs and gutters.
 - e. Sidewalks.
 - f. Thrust blocks.
3. Class "C" concrete shall be used for precast concrete

D. Related Sections:

1. Section 05 05 33, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ACI 224R, Control of Cracking in Concrete Structures.
2. ACI 301, Specifications for Structural Concrete for Buildings.
3. ACI 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305R, Specification for Hot Weather Concreting.
5. ACI 306R, Cold Weather Concreting.
6. ACI 309R, Guide for Consolidation of Concrete.

7. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
8. ACI 347, Guide to Formwork for Concrete.
9. ACI SP-66, ACI Detailing Manual.
10. ASTM A82/A82M, Specification for Steel Wire, Plain, for Concrete Reinforcement.
11. ASTM A185/A185M, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
12. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
13. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
14. ASTM C33/C33M, Specification for Concrete Aggregates.
15. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
16. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
16. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
17. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
18. ASTM C143/C143M, Test Method for Slump of Hydraulic-Cement Concrete.
19. ASTM C150/C150M, Specification for Portland Cement.
20. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
21. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
23. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
24. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
25. ASTM C579, Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
26. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
27. ASTM D1752, Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
28. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials
29. ASTM E1745, Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
30. CRD-C 572, U. S. Army Corps of Engineers Specification for Polyvinylchloride Waterstops.
31. CRSI 1MSP, Manual of Standard Practice.

1.3 QUALITY ASSURANCE

A. Laboratory Trial Batch:

1. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
2. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
3. Perform the following testing on each trial batch:
 - a. Aggregate gradation for fine and coarse aggregates.

- b. Slump.
 - c. Air content.
 - d. Compressive strength based on three cylinders each tested at seven days and at 28 days.
4. Submit for each trial batch the following information:
- a. Project identification name and number (if applicable).
 - b. Date of test report.
 - c. Complete identification of aggregate source of supply.
 - d. Tests of aggregates for compliance with the Contract Documents.
 - e. Scale weight of each aggregate.
 - f. Absorbed water in each aggregate.
 - g. Brand, type, and composition of cementitious materials.
 - h. Brand, type, and amount of each admixture.
 - i. Amounts of water used in trial mixes.
 - j. Proportions of each material per cubic yard.
 - k. Gross weight and yield per cubic yard of trial mixtures.
 - l. Measured slump.
 - m. Measured air content.
 - n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28-day test, and for each design mix.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. List of concrete materials and concrete mix designs proposed for use. Include results of tests performed to qualify the materials and to establish the mix designs. Do not start laboratory trial batch testing until this submittal is approved by ENGINEER.
 - b. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.
 - c. Concrete placement drawings showing the location and type of all joints.
 - d. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI SP-66. For walls and masonry construction, provide elevations to a minimum scale of 1/4-inch to one foot. Show bar schedules, stirrup spacing, adhesive dowels, splice lengths, diagrams of bent bars, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing.
- 2. Product Data:
 - a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
- 3. Samples:
 - a. Samples: Submit samples of materials as specified and as otherwise requested by ENGINEER, including names, sources, and descriptions.

B. Informational Submittals: Submit the following:

- 1. Site Quality Control Submittals:
 - a. Report of testing results for testing of field concrete cylinders for each required time period. Submit within 24 hours after completion of

associated test. Test report shall include results of all testing required at time of sampling.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Transportation, Delivery, and Handling:
 - 1. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.
 - 2. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.
 - 3. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.
 - 4. Deliver grout materials from manufacturers in unopened containers that bear intact manufacturer labeling.
- B. Storage:
 - 1. Store formwork materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.
 - 2. Store concrete reinforcing materials to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground. Space framework or blocking supports to prevent excessive deformation of stored materials.
 - 3. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight.
 - 4. For storage of concrete materials, provide bins or platforms with hard, clean surfaces.

PART 2 – PRODUCTS

2.1 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I/II or ASTM C595, Type IL. Type IL cement shall meet the following requirements:
 - a) Type IL cement shall have moderate sulfate resistance (MS) per ASTM C1157.
 - b) Type IL cement shall have a maximum heat of hydration no more than 68 (cal/g) or 284.5 (KJ/kg) per ASTM 1702.
 - c) Type IL cement Tricalcium Aluminate content shall not exceed 8%.
- B. Aggregates: ASTM C33/C33M.
 - 1. Fine Aggregate: Clean, sharp, natural silica sand free of loam, clay, lumps, and other deleterious substances. Dune sand, bank run sand, and manufactured sand are unacceptable.
 - 2. Coarse Aggregate:
 - a. Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.
 - b. Coarse aggregate shall comply with the following:
 - 1) Crushed stone, processed from natural rock or stone.
 - 2) Washed gravel, either natural or crushed. Slag, pit gravel, and

- bank-run gravel are not allowed.
- c. Coarse Aggregate Size: ASTM C33/C33M, Nos. 57 or 67, unless otherwise approved by ENGINEER.

C. Water: Clean, potable.

D. Admixtures:

1. Air-Entraining Admixture: ASTM C260.
2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
3. Water Reducing and Set-Adjusting Admixtures: ASTM C494/C494M, Types D and E.
4. High Range Water-Reducing Admixture: ASTM C494/C494M, Type F/G.
5. Use only admixtures that have been tested and approved in the mix designs.
6. Do not use calcium chloride or admixtures containing chloride ions.

E. Cementitious Materials:

- a. Fly Ash ASTM C618, Class F, content in cementitious material up to 20% by weight.
- b. Slag ASTM C989, Grade 120, content in cementitious material up to 20% by weight.

2.2 CONCRETE MIX

A. General:

1. Normal weight: 145 pounds per cubic foot.
2. Use air-entraining admixture in all concrete. Provide not less than four percent, nor more than eight percent, entrained air for concrete exposed to freezing and thawing, and provide from three to five percent entrained air for other concrete.

B. Proportioning and Design of Concrete Mixes:

1. TABLE 03 00 05-A

CONCRETE DESIGN MIX CRITERIA

Concrete Class	Coarse Aggregate ⁽¹⁾		Minimum	Max. W/CM ⁽⁴⁾	Slump ⁽²⁾	Min. Comp Strength ⁽³⁾ (psi)
	Size A	Size B	Cementitious ⁽⁵⁾ (lbs/cu yd)			
Class "A"	No. 57	No. 8	535	0.42	4" max.	4,500
Class "B"	No. 57 or No. 67		517	0.50	4" max.	3,000
Class "C"	N. 57 or No. 67		560	0.40	4" max.	5,000

Notes Applicable to Table 03 00 05-A:

1. Coarse aggregate size numbers refer to ASTM C33. Where Size A and B are designated in Table 03 00 05-A, it is intended that the smaller Size B

aggregate is to be added, replacing a portion of the coarse or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with sand content not exceeding 41 percent of total aggregate.

2. Slumps indicated are prior to addition of high range water reducing admixture or plasticizing admixture.
3. Quantity of water to be used in the determination of water-cementitious materials (W/CM) ratio shall include free water on aggregates in excess of SSD and water portion of admixtures.

C. Adjustment of Concrete Mixes:

1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
2. Submit for ENGINEER's approval laboratory test data for adjusted concrete mix designs, including compressive strength test results.
3. Implement adjusted mix designs only after ENGINEER's approval.
4. Adjustments to concrete mix designs shall not result in additional costs to OWNER.

2.3 FORM MATERIALS

- A. Provide form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection. CONTRACTOR shall be responsible for designing the formwork system to resist all applied loads including pressures from fluid concrete and construction loads.
- B. Smooth Form Surfaces: Acceptable panel-type to provide continuous, straight, smooth, as-cast surfaces in accordance with ACI 301.
- C. Unexposed Concrete Surfaces: Material to suit project conditions.
- D. Provide 3/4-inch chamfer at all external corners. Chamfer is not required at re-entrant corners unless otherwise shown or indicated.
- E. Form Ties:
 1. Provide factory-fabricated, removable, or snap-off metal form ties, that prevent form deflection and prevent spalling of concrete surfaces upon removal. Materials used for tying forms are subject to approval of ENGINEER.
 2. Unless otherwise shown or indicated, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1.5 inches from outer surface of concrete. Unless otherwise shown or indicated, provide form ties that, upon removal, will leave a uniform, circular hole not larger than one-inch diameter in the concrete surface.
 3. Ties for exterior walls, below-grade walls, and walls subject to hydrostatic pressure shall be provided with waterstops.
 4. Wire ties are unacceptable.

2.4 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed bars.

- B. Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete: ASTM A1064/ASTM A1064M.
- C. Provide supports for reinforcing including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing in place.
 - 1. Use wire bar-type supports complying with CRSI MSP1 recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
 - 2. For slabs on grade, use precast concrete blocks, four inches square minimum with compressive strength equal to or greater than the surrounding concrete, or supports with sand plates or horizontal runners where base materials will not support chair legs.
 - 3. For all concrete surfaces where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic-protected, or stainless steel legs in accordance with CRSI MSP1.
 - 4. Provide precast concrete supports over waterproof membranes.
- D. Adhesive Dowels:
 - 1. Dowels:
 - a. Dowel reinforcing bars shall comply with ASTM A615, Grade 60.
 - 2. Adhesive:
 - a. For requirements for adhesive, refer to Section 05 05 33, Anchor Systems.

2.5 RELATED MATERIALS

- A. Waterstops:
 - 1. PVC Waterstops:
 - a. Manufacturers: Provide products of one of the following:
 - 1) W.R. Meadows, Inc.
 - 2) Greenstreak Plastic Products Company.
 - 3) Or approved equal.
 - b. Waterstops shall comply with CRD-C 572. Do not use reclaimed or scrap material.
 - c. Minimum Thickness: 3/8-inch.
 - d. Provide waterstops with minimum of seven ribs equally spaced at each end on each side with the first rib located at the edge. Each rib shall be minimum 1/8-inch in height.
 - e. Construction Joints: Waterstops shall be six-inch wide flat-strip type.
 - f. Expansion Joints: Waterstops shall be nine-inch wide centerbulb type.
 - 2. Hydrophilic Waterstops:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Duroseal Gasket, by BBZ USA, Inc.
 - 2) Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
 - 3) Hydrotite, by Greenstreak Plastic Products Company.
 - 4) Or approved equal.
 - b. Hydrophilic waterstop materials shall be bentonite-free and shall expand by minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
 - c. Waterstop material shall be composed of resins and polymers that absorb water and cause a completely reversible and repeatable

- increase in volume.
 - d. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
 - e. Select material in accordance with manufacturer's recommendations for type of liquid to be contained.
 - f. Minimum cross-sectional dimensions: 3/16-inch by 3/4-inch.
 - g. Location of hydrophilic waterstops shall be as shown or indicated on the Drawings, or where approved by ENGINEER.
 - h. Hydrophilic Sealant: Shall adhere firmly to concrete, metal, and PVC in dry or damp condition and be indefinitely elastic when cured.
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Duroseal Paste, by BBZ USA, Inc.
 - b) Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
 - c) Hydrotite, by Greenstreak Plastic Products Company.
 - d) Or approved equal.
- B. Vapor Retarder:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.
 - b. Griffolyn 10-mil, by Reef Industries.
 - c. Moistop Ultra, by Fortifiber Industries.
 - d. Or approved equal.
 - 2. Vapor retarder membrane shall comply with the following.
 - a. Water Vapor Transmission Rate, ASTM E96/E96M: 0.04 perms or lower.
 - b. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
 - c. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
 - d. Provide accessories by same manufacturer as vapor retarder.
- C. Membrane-Forming Curing Compound: ASTM C309, Type I.
- D. Epoxy Bonding Agent:
 - 1. Two-component epoxy resin bonding agent.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Sikadur 32, Hi-Mod LPL, by Sika Corporation.
 - b. Eucopoxy LPL, by the Euclid Chemical Company.
 - c. Or approved equal.
- E. Epoxy-Cement Bonding Agent:
 - 1. Three-component blended epoxy resin-cement bonding agent.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Sika Armathec 110 EpoCem, by Sika Corporation.
 - b. Duralprep A.C., by Euclid Chemical Company.
 - c. Or approved equal.
- F. Preformed Expansion Joint Filler:
 - 1. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).
- G. Joint Sealant and Accessories:
 - 1. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07 92 00, Joint Sealants.

2.6 GROUT

- A. Non-shrink Grout:
 - 1. Pre-packaged, non-metallic, cementitious grout requiring only the addition of water at the Site.
 - 2. Minimum 28-day Compressive Strength: 7,000 psi.
 - 3. Products and Manufacturers: Provide one of the following:
 - a. NS Grout by Euclid Chemical Company.
 - b. Set Grout by Master Builders, Inc.
 - c. NBEC Grout by Five Star Products, Inc.
 - d. Or approved equal.
- B. Epoxy Grout:
 - 1. Pre-packaged, non-shrink, non-metallic, 100 percent solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.
 - 2. Minimum Seven-day Compressive Strength: 14,000 psi, when tested in accordance with ASTM C579.
 - 3. Products and Manufacturers: Provide one of the following:
 - a. Euco High Strength Grout, by Euclid Chemical Company.
 - b. Sikadur 42, Grout Pak, by Sika Corporation.
 - c. Five Star Epoxy Grout, by Five Star Products, Inc.
 - d. Or approved equal.
- C. Grout Fill:
 - 1. Grout mix shall consist of cement, fine and coarse aggregates, water, and admixtures complying with requirements specified in this Section for similar materials in concrete.
 - 2. Proportion and mix grout fill as follows:
 - a. Minimum Cement Content: 564 pounds per cubic yard.
 - b. Maximum Water-Cement Ratio: 0.45.
 - c. Maximum Coarse Aggregate size: 1/2-inch, unless otherwise indicated.
 - d. Minimum 28-day Compressive Strength: 4,000 psi.

2.7 LIQUID SEALER/DENSIFIER

- A. High performance, deeply penetrating concrete densifier, odorless, colorless, VOC compliant, non-yellowing silicate based solution designed to harden, dustproof and protect concrete floors. The compound must contain a minimum solids content of 20% of which 50% is silicate.
- B. Product and Manufacturer: Provide one of the following:
 - 1. Euco Diamond Hard by Euclid Chemical Company.
 - 2. Sealhard by L & M Chemical Company.
 - 3. Or approved equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the substrate and the conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory

conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 FORMWORK

- A. Construct formwork in accordance with ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation, and position.
- B. Provide openings in formwork to accommodate the Work of other trades. Accurately place and securely support items required to be built into formwork.
- C. Clean and adjust forms prior to placing concrete. Apply form release agents or wet forms as required. Re-tighten forms during and after concrete placing, when required, to eliminate cement paste leaks.
- D. Removing Formwork:
 - 1. Comply with ACI 301 and ACI 347, except as otherwise indicated in the Contract Documents.
 - 2. Do not remove formwork and shoring until supported concrete members have acquired minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field-cured specimens may be submitted to ENGINEER for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated in the Contract Documents.
 - 3. Removal time for formwork is subject to ENGINEER's acceptance.
 - 4. Repair form tie-holes following in accordance with ACI 301.

3.3 REINFORCING, JOINTS, AND EMBEDDED ITEMS

- A. Comply with the applicable recommendations of Laws and Regulations and standards referenced in this Section, including CRSI MSP1, for details and methods of placing and supporting reinforcing.
- B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials which act to reduce or destroy bond between reinforcing material and concrete.
- C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by means of metal chairs, runners, bolsters, spacers, and hangers, as required.
 - 1. Place reinforcing to obtain minimum concrete coverages as shown on the Drawings and as required in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set with ties so that twisted ends are directed away from exposed concrete surfaces.
 - 2. Do not secure reinforcing to formwork using wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.
- D. Provide sufficient quantity of supports of strength required to carry reinforcing. Do not place reinforcing more than two inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

- E. Splices: Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown or indicated for minimum lap of spliced bars, as shown on Drawings.
- F. Install welded wire fabric in lengths as long as practical, lapping adjoining sections a minimum of one full mesh.
- G. Do not place concrete until reinforcing is inspected and ENGINEER indicates that conditions are acceptable for placing concrete. Concrete placed in violation of this paragraph will be rejected. Notify ENGINEER in writing at least two working days prior to proposed concrete placement.
- H. Construction Joints:
 - 1. Comply with requirements of ACI 301 and the Contract Documents.
 - 2. Locate and install construction joints as shown or indicated on the Drawings. Where not shown or indicated, locate joints to not impair strength of the structure; position joints at points of minimum shear. Location of joints shall be approved by ENGINEER. In addition to joints shown or indicated on the Drawings, locate construction joints as follows:
 - a. In foundation mats, locate joints at spacing of approximately 40 feet. Joints shall be located within middle third of element span, unless otherwise shown or indicated on the Drawings. Element span shall be considered distance between piles or, as determined by ENGINEER, distance between bearing elements, such as columns, exterior walls and interior walls. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.
 - b. In walls, locate joints at a maximum spacing of 40 feet. Locate joints away from wall intersections a minimum of one-quarter of the clear span distance between wall intersections measured horizontally.
 - c. In structural slabs and beams, joints shall be located within middle third of element span and shall be located in compliance with ACI 301, unless otherwise shown or indicated on the Drawings.
 - d. In slabs on grade, locate joints at spacing of approximately 40 feet. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.
 - 3. Horizontal Joints:
 - a. Roughen concrete at interface of construction joints by abrasive blasting, hydroblasting, or using surface retardants and water jets to expose aggregate and remove accumulated concrete on projecting rebar immediately subsequent to form stripping, unless otherwise approved by ENGINEER. Immediately before placing fresh concrete, thoroughly clean existing contact surface using stiff brush or other tools and stream of pressurized water. Surface shall be clean and wet, and free from pools of water at time of placing fresh concrete.
 - b. Remove laitance, waste mortar, and other substances that may prevent complete adhesion. Where joint roughening was performed more than seven days prior to concrete placing or where dirt or other bond reducing contaminants are on surface, perform additional light abrasive blasting or hydroblasting to remove laitance and all bond-reducing materials just prior to concrete placement.
 - 4. Vertical Joints:
 - a. Apply roughener to the form in thin, even film by brush, spray, or roller in accordance with manufacturer's instructions. After roughener

- is dry, concrete may be placed.
- b. When concrete has been placed, remove joint surface forms as early as necessary to allow for removal of surface retarded concrete. Forms covering member surfaces shall remain in place as required. Wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by ENGINEER. Alternately, surface shall be roughened by abrasive blasting or hydroblasting to expose aggregate. Outer one-inch of each side of joint face shall be masked and protected from blasting to avoid damaging member surface.
5. Where construction joints are indicated to be roughened, intentionally roughen surfaces of previously-placed concrete to amplitude of 1/4-inch.
- I. Isolation Joints:
1. Provide isolation joint where sidewalk or other slab on grade abuts a concrete structure and slab on grade is not shown doweled into that structure. Form isolation joint by 1/2-inch joint filler with upper 1/2-inch of joint filled with sealant.
- J. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by, cast-in-place concrete. Use setting diagrams, templates, and instructions provided under other Sections and, when applicable, other contracts for locating and setting. Refer to Paragraph 1.1.B of this Section. Do not embed in concrete uncoated aluminum items. Where aluminum items are in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.
- K. Adhesive Dowels:
1. Adhesive dowels shall be reinforcing bar dowels set in an adhesive in hole drilled into hardened concrete. Comply with adhesive system manufacturer's installation instructions regarding hole diameter, drilling method, embedment depth required to fully develop required tensile strength, and hole cleaning and preparation instructions. Unless more-stringent standards are required by adhesive system manufacturer, comply with the following.
 2. Drill holes to adhesive system manufacturer's recommended diameter and depth to develop required tensile strength. Where indicated on the drawings, hole depths greater than required for tensile development shall be provided. Hammer-drill holes. Cored holes are not allowed.
 3. Embedment depths shall be based on concrete compressive strength of 4,000 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.
 4. Determine location of existing reinforcing steel in vicinity of proposed holes prior to drilling. Adjust location of holes to be drilled to avoid drilling through or damaging existing reinforcing bars only when approved by ENGINEER.
 5. Before setting adhesive dowel, hole shall be free of dust and debris using method recommended by adhesive system manufacturer. Hole shall be brushed, with manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
 6. Inject adhesive into hole through injection system mixing nozzle and necessary extension tubes, placed to bottom of hole. Withdraw discharge

end as adhesive is placed, but keep end of tube immersed to prevent forming air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placement.

7. Twist dowels during insertion into partially-filled hole to guarantee full wetting of bar surface with adhesive. Insert bar slowly to avoid developing air pockets.

3.4 CONCRETE PLACING

- A. Site Mixing: Use drum-type batch machine mixer, mixing not less than 1.5 minutes for one cubic yard or smaller capacity. Increase required mixing time by minimum of 15 seconds for each additional cubic yard or fraction thereof.
- B. Ready-Mixed Concrete: Comply with ASTM C94/C94M.
- C. Concrete Placing:
 1. Place concrete in a continuous operation within planned joints or sections in accordance with ACI 304R.
 2. Do not begin placing concrete until work of other trades affecting concrete is completed.
 3. Wet concrete and subgrade surfaces to saturated surface dry condition immediately prior to placing concrete.
 4. Deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
 5. Avoid separation of the concrete mixture during transportation and placing. Concrete shall not free-fall for distance greater than four feet during placing.
 6. Complete concrete placing within 90 minutes of addition of water to the dry ingredients.
- D. Consolidate placed concrete in accordance with ACI 309R using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around placing and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly-spaced locations. Do not use vibrators to transport concrete within the formwork. Vibration of formwork or placing is not allowed.
- E. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placing, and curing.
 1. In hot weather comply with ACI 305R.
 2. In cold weather comply with ACI 306R.

3.5 QUALITY OF CONCRETE WORK

- A. Make concrete solid, compact, smooth, and free of laitance, cracks, and cold joints.
- B. Concrete for liquid-retaining structures and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
- C. Cut out and properly replace to extent directed by ENGINEER, or repair to satisfaction of ENGINEER, surfaces that contain cracks or voids, are unduly rough, or are in defective in any way. Patches or plastering are unacceptable.

- D. Repair, removal and replacement of defective concrete directed by ENGINEER shall be at no additional cost to OWNER.

3.6 CURING

- A. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing by using moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed. Provide protection, as required, to prevent damage to exposed concrete surfaces. Total curing period shall not be less than seven days. Curing methods and materials shall be compatible with scheduled finishes.

3.7 FINISHING

- A. Slab Finish:
1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Use a wood float only. Check and level surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float the surface to a uniform, smooth, granular texture. Slab surfaces shall receive a float finish. Provide additional trowel finishing as required in this Section.
 2. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
 3. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten-foot straightedge. Grind smooth surface defects that would telegraph through applied floor covering system.
 4. Use trowel finish for the following:
 - a. Interior exposed slabs, unless otherwise shown or indicated.
 - b. Apply non-slip broom finish, after troweling, to exterior concrete slab and elsewhere as shown.
- B. Apply liquid sealer/densifier to exposed exterior concrete slabs when cured and dry, in accordance with manufacturer's instructions.
- C. Formed Finish:
1. Provide smooth form concrete finish at exposed surfaces. Use largest practical form panel sizes to minimize form joints. Exposed surfaces include interior water-contacting surfaces of tanks, whether or not directly visible. All surfaces shall be considered as exposed, unless buried or covered with permanent structural or architectural material. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/8-inch in height. Where surface will be coated or will receive further treatment, remove all fins flush with concrete surface.

2. Provide rough form finish at all unexposed surfaces. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/2-inch in height.

3.8 GROUT PLACING

- A. Place grout as shown and indicated, and in accordance with grout manufacturer's instructions and recommendations. If grout manufacturer's instructions conflict with the Contract Documents, notify ENGINEER and not proceed until obtaining ENGINEER's clarification.
- B. Dry-packing is not allowed, unless otherwise indicated.
- C. Manufacturers of proprietary grout materials shall make available upon 72 hours notice the services of qualified, full-time, factory-trained employee to aid in ensuring proper use of grout materials at the Site.
- D. Placing grout shall comply with temperature and weather limitations described in Article 3.4 of this Section.

3.9 FIELD QUALITY CONTROL

- A. Site Testing Services:
 1. CONTRACTOR shall employ independent testing laboratory to perform field quality control testing for concrete. ENGINEER will direct where samples are obtained.
 2. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
 3. CONTRACTOR shall provide curing and necessary cylinder storage.
- B. Quality Control Testing During Construction:
 1. Perform sampling and testing for field quality control during concrete placing, as follows:
 - a. Sampling Fresh Concrete: ASTM C172.
 - b. Slump: ASTM C143/C143M; one test for each concrete load at point of discharge.
 - c. Concrete Temperature: ASTM C1064/C1064M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
 - d. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
 - e. Unit Weight: ASTM C138/C138M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
 - f. Compression Test Specimens:
 - 1) In accordance with ASTM C31/C31M, make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by ENGINEER.
 - 2) Cast, store, and cure specimens in accordance with ASTM C31/C31M.
 - g. Compressive Strength Tests:

- 1) In accordance with ASTM C39/C39M; one specimen tested at seven days, and three specimens tested at 28 days.
- 2) Concrete that does not comply with strength requirements will be considered as defective Work.
- h. Submit test results from certified by testing laboratory to ENGINEER within 24 hours of completion of test.
- i. When there is evidence that strength of in-place concrete does not comply with the Contract Documents, CONTRACTOR shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42/C42M and the following:
 - 1) Obtain at least three representative cores from each concrete member or suspect area of concrete at locations directed by ENGINEER.
 - 2) Strength of concrete for each series of cores will be acceptable if average compressive strength is at least 85 percent of specified compressive strength and no single core is less than 75 percent of required 28-day required concrete compressive strength.
 - 3) Testing laboratory shall submit test results to ENGINEER on same day that tests are completed. Include in test reports Project name and number (if any), date of sampling and testing, CONTRACTOR name, name of concrete testing laboratory, exact location of test core in the Work, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength, and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of concrete as placed, and moisture condition of the core at time of testing.
- j. Fill core holes solid with non-shrink grout in accordance with this Section and finish to match adjacent concrete surfaces.
- k. If results of core tests are unacceptable or if it is impractical to obtain cores, perform static load test and evaluations complying with ACI 318 and ACI 350, as directed by ENGINEER.
2. OWNER Will employ testing laboratory to perform field quality testing of adhesive dowels at the Site.
 - a. Testing shall comply with ASTM E488.
 - b. After adhesive system manufacturer's recommended curing period and prior to placing connecting reinforcing, proof-test for pullout ten percent of adhesive dowels installed. If one or more dowels fail the test, CONTRACTOR shall pay cost to test all dowels of same diameter and type installed on the same day as the failed dowel.
 - c. Test dowels to 60 percent of specified yield strength. ENGINEER will direct which dowels are to be tested.
 - d. Apply test loads with hydraulic ram.
 - e. Displacement of dowels shall not exceed D/10, where D is nominal diameter of dowel.
 - f. Dowels that fail shall be reinstalled and retested at CONTRACTOR's expense.

+ + END OF SECTION + +

SECTION 05 05 33

ANCHOR SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all professional services labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
 - 2. This Section includes all anchor systems required for the Work, but not specified under other Sections.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ACI 318, Building Code Requirements for Structural Concrete.
 - 2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
 - 3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
 - 4. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills And Blanks For Carbide-tipped Masonry Drills.
 - 5. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
 - 6. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - 7. ASTM A276, Specification for Stainless Steel Bars and Shapes.
 - 8. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
 - 9. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
 - 10. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 11. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - 12. ASTM C307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
 - 13. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - 14. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
 - 15. ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 16. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
 - 17. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.

18. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
19. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
20. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
21. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
22. FS A-A-1923A, Concrete Expansion Anchors.
23. FS A-A-1925A, Shield, Expansion (Nail Anchors).
24. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
25. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
26. ICC-ES AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements.
27. ICC-ES AC60, Acceptance Criteria for Anchors in Unreinforced Masonry Elements.
28. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
29. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
30. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
31. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
 2. Professional Engineer:
 - a. CONTRACTOR or delegated system manufacturer shall retain a registered professional engineer legally qualified to practice in the same state as the Site.
 - b. Responsibilities include:
 - 1) Reviewing anchor system performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising preparation of design calculations and related Shop Drawings.
 - 4) Signing and sealing all design calculations and Shop Drawings.
 - 5) Certifying that:
 - a) Design of anchor systems has been performed in accordance with performance and design criteria stated in the Contract Documents, and
 - b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.
 3. Post-installed Anchor Installer:
 - a. Mechanical and Adhesive anchors, except as noted in 1.3.A.4 b: Installer shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or

manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.

- b. Adhesive Anchors: Installation of horizontal or vertically inclined adhesive anchors shall be performed by personnel certified under an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchors Installer Certification Program, or equivalent. Description of equivalent programs shall be submitted for ENGINEER's approval and acceptance by the building official having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
- 2. Product Data:
 - a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
 - b. Copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.

B. Delegated Design Submittals:

- 1. Design Data: Submit the following:
 - a. Design Calculations for delegated anchor systems. Structural calculations shall include all specified performance criteria. The magnitude of delegated system/anchorage reactions to supporting structure shall be clearly noted. Design calculations shall be signed, sealed and dated by CONTRACTOR's professional engineer.

C. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
 - 1) Reports shall demonstrate compliance with ductile steel element definition of ACI 350, Appendix D, or ACI 318 .
 - b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
 - c. For each required adhesive anchor installer, submit ACI/CRSI Adhesive Anchor Installer Certification.
- 2. Manufacturer's Instructions:
 - a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).
- 3. Field Quality Control Submittals:
 - a. Submit results of field quality control testing and inspections performed by testing laboratory.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage and Protection:
 - 1. Keep materials dry during delivery and storage.
 - 2. Store adhesive materials within manufacturer's recommended storage temperature range.
 - 3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. General:
 - 1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
 - 2. Stainless Steel Nuts:
 - a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.
 - b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.
 - 3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.
- B. Design Criteria
 - 1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:
 - a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.
 - b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.

- 1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed in an area that is not expected to crack under any and all conditions of design loading.
 - 2) Concrete Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.
 - 3) Concrete Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
 - 4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.
 - 5) Concrete Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
 - 6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by ENGINEER, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.
2. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to CONTRACTOR, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents. Anchor system shall be designed by a professional engineer, retained by CONTRACTOR, Subcontractor, or Supplier, registered in the same state as the Site, with proper consideration of concrete strength, spacing and edge distance
 - a. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:
 - 1). Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.
 - 2). Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
 - 3). Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized

to support such loads in addition to the weight of the equipment, piping, or system, as applicable.

C. Application:

1. Anchor Bolts:
 - a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by ENGINEER.
 - b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
2. Concrete Adhesive Anchors:
 - a. Use where adhesive anchors are shown or indicated for installation in concrete.
 - b. Suitable for use where subject to vibration.
 - c. Suitable for use in exterior locations or locations subject to freezing.
 - d. Suitable for use in submerged, intermittently submerged, or buried locations.
 - e. Do not use in overhead applications, unless otherwise shown or approved by ENGINEER.
 - f. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
3. Concrete Masonry Adhesive Anchors:
 - a. Use where adhesive anchors are shown or indicated for installation in grout-filled or hollow masonry units.
 - b. Suitable for use where subject to vibration.
 - c. Suitable for use in exterior locations or locations subject to freezing.
 - d. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
4. Concrete Wedge Expansion Anchors:
 - a. Use where expansion anchors are shown or indicated for installation in concrete.
 - b. Do not use where subject to vibration.
 - c. Do not use in exterior locations or locations subject to freezing.
 - d. Do not use in submerged, intermittently submerged, or buried locations.
 - e. Suitable for use in overhead applications.
5. Grout-filled Concrete Masonry Wedge Expansion Anchors:
 - a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.
 - b. Do not use where subject to vibration.
 - c. Do not use in exterior locations or locations subject to freezing.
6. Hollow Concrete Masonry Sleeve Expansion Anchors:
 - a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
 - b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use where subject to vibration.
 - d. Do not use in exterior locations or locations subject to freezing.
7. Drop-in Expansion Anchors:
 - a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.

- b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use where subject to vibration.
 - d. Do not use at submerged, intermittently submerged, or buried locations.
 - e. Do not use in exterior locations or locations subject to freezing.
 - f. Suitable for use in overhead applications.
- 8. Concrete Undercut Anchors:
 - a. Use where undercut anchors are shown or indicated for installation in concrete.
 - b. Suitable for use where subject to vibration.
 - c. Do not use in submerged, intermittently submerged, or buried locations.
 - d. Do not use in exterior locations or locations subject to freezing.
 - e. Suitable for use in overhead applications.
- 9. Concrete Inserts:
 - a. Use only where shown or indicated in the Contract Documents.
 - b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
- 10. Drive-In Expansion Anchors:
 - a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.
 - b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use in overhead applications.
- 11. For Use in Precast Concrete Planks:
 - a. To support piping or conduit two-inch diameter and smaller, use low-profile drop-in anchors, hollow concrete masonry adhesive anchors, or through-bolts.
 - b. For piping greater than two-inch diameter, or to support safety-related systems, use through-bolts. Each through-bolt shall consist of threaded rod, nuts, washers, and bearing plate.

2.2 MATERIALS

- A. Anchor Bolts:
 - 1. Interior Dry Non-corrosive Locations: Provide straight threaded carbon steel rods complying with ASTM F1554, Grade 36, with heavy hex nuts complying with ASTM A563 Grade A, unless otherwise shown or indicated on the Drawings. Hooked anchor bolts are unacceptable.
 - 2. Exterior, Buried, Submerged Locations, or When Exposed to Wastewater: Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by ENGINEER. Hooked bolts are unacceptable.
 - 3. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall

be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.

4. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:

1. General:
 - a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
 - a. HIT-RE 500-V3 Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
 - b. HIT-HY 200-A and HIT-HY 200-R Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
 - c. SET-XP Adhesive anchoring system, by Simpson Strong-Tie Company, Inc.
 - d. Or approved equal.
3. Adhesive:
 - a. Adhesive system shall use two-component adhesive mix.
 - b. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308, which incorporates the requirements of ACI 355.4-11
4. Anchor:
 - a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

C. Concrete Wedge Expansion Anchors:

1. General:
 - a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
2. Products and Manufacturers: Provide one of the following:
 - a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
 - b. Strong Bolt 2 Wedge Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 304 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.

6. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

D. Drop-in Expansion Anchors:

1. General:
 - a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
2. Products and Manufacturers: Provide one of the following:
 - a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
 - b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.

E. Concrete Undercut Anchors:

1. General:
 - a. Each concrete undercut anchor shall consist of threaded stud, thick-walled expansion sleeve, expander coupler, and nut and washer. Anchors shall be pre-set type or through-set type, as shown on the Drawings.
2. Products and Manufacturers: Provide one of the following:
 - a. HDA Undercut Anchor, by Hilti Fastening Systems, Inc.
 - b. DUC Ductile Undercut Anchor, by USP Structural Connectors.
 - c. Or approved equal
3. Provide concrete undercut expansion anchors in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete undercut anchors in accordance with ACI 355.2 prequalification tests.
 - a. Anchor shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.
4. Installed anchor shall exhibit form fit between bearing elements and the undercut in the concrete.
5. Interior Dry Non-Corrosive Locations: Provide carbon steel anchors, complete with nuts and washers, zinc plated, in accordance with ASTM B633.
6. Other Locations: Provide stainless steel anchors, complete with nuts and washers, manufactured of AISI Type 316 stainless steel or materials complying with ISO 3506-1 and having corrosion resistance equivalent to AISI Type 316 stainless steel.
7. Concrete undercut anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete for seismic recognition for seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

F. Concrete Inserts:

1. Manufacturers: Provide products of one of the following:
 - a. Unistrut Corporation.
 - b. Cooper B-Line, Inc.
 - c. Anvil International, Inc.
 - d. Or approved equal.

2. Spot Concrete Inserts:
 - a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
 3. Continuous Concrete Inserts:
 - a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.
 4. Provide inserts with plain finish.
- G. Drive-In Expansion Anchors:
1. General:
 - a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.
 2. Products and Manufacturers: Provide one of the following:
 - a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.
 - b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
 3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.
- H. Unless approved by ENGINEER, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.
- I. Anti-Seizing Compound:
1. Products and Manufacturers: Provide one of the following:
 - a. Pure Nickel Never-Seez, by Bostik.
 - b. Nickel-Graf, by Anti-Seize Technology.
 - c. Or equal.
 2. Provide pure nickel anti-seizing compound.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials will be installed and advise ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Anchor Bolts:
1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
 2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.

3. Protect threads and shank from damage during installation and subsequent construction operations.
- B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:
1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain ENGINEER's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.
- C. Adhesive Anchors:
1. Installation conditions shall comply with all requirements of the approved product Evaluation Service Report (ESR), including "Conditions of Use." Comply with manufacturer's written installation instructions and the following.
 2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
 3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
 4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
 5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
 6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
 7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
 8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by ENGINEER.
 9. Limitations:
 - a. Core drilled holes shall not be allowed
 - b. At time of anchor installation, concrete shall have compressive strength (f'_c) of not less than 3,000 psi.
 - c. At time of anchor installation, concrete shall have age of not less than 21 days.
 - d. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.

- e. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by CONTRACTOR.
- f. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 3,000 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.
- g. Obstructions in drill path: When existing reinforcing steel is encountered during drilling, stop and do not damage existing reinforcing. Obtain ENGINEER approval for any required modifications.

D. Expansion Anchors:

- 1. Comply with expansion anchor manufacturer's written installation instructions and the following:
- 2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.
- 3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
- 4. Before installing anchor, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
- 5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.

E. Concrete Undercut Anchors:

- 1. Comply with undercut anchor manufacturer's written installation instructions and the following.
- 2. Protect threads from damage during anchor installation.
- 3. Drill hole to anchor manufacturer's specified depth and diameter using a drill bit matched to the specific anchor.
- 4. Before setting the undercut anchor, hole shall be free of dust and debris using method recommended by undercut anchor system manufacturer. Hole shall be blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
- 5. Insert the anchor by hand until anchor reaches bottom of hole.
- 6. Set anchor in accordance with manufacturer's instructions using anchor manufacturer's specified setting tool.
- 7. Verify that the setting mark is visible on the threaded rod above the sleeve.
- 8. Anchor shall be set to manufacturer's recommended torque, using a torque wrench.

F. Concrete Inserts:

- 1. Comply with concrete insert manufacturer's installation instructions.
- 2. Inserts shall be flush with slab bottom surface.
- 3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.

4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.
- G. Anti-Seizing Compound:
1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.1.B of this Section.
 2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.3 CLEANING

- A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

1. Furnish services of independent testing laboratory to perform field quality tensile testing of production adhesive anchors at the Site, unless otherwise specified.
 - a. Testing shall comply with ASTM E488.
 - b. Test at least ten percent of all types of adhesive anchors. If one or more adhesive anchors fail the test, CONTRACTOR shall pay cost of testing all anchors of the same type installed in the Work. CONTRACTOR shall be responsible for retesting costs. c. ENGINEER will direct which adhesive anchors are to be tested and indicate test load to be used
 - d. Apply test loads with hydraulic ram.
 - e. Displacement of post-installed anchors shall not exceed $D/10$, where D is nominal diameter of anchor being tested.
 - 1) Load each test anchor to failure.
 - 2) Testing shall comply with ASTM E488.
 - 3) Apply test loads with hydraulic ram.
 - f. Anchors that fail to reach the specified test load shall be considered as not passing the test and shall be re-tested at no additional cost to OWNER.
 - g. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.
 2. Correct defective Work by removing and replacing or correcting, as directed by ENGINEER.
 3. CONTRACTOR shall pay for all corrections and subsequent testing required to confirm competence in the installation of post-installed mechanical anchors.
 4. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.
- B. Manufacturer's Services:
1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train CONTRACTOR's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

+ + END OF SECTION + +

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all professional service, labor, materials, equipment, and incidentals as shown, specified, and required to furnish miscellaneous metal fabrications including surface preparation and shop priming.
2. The Work also includes:
 - a. Providing openings in miscellaneous metal fabrications to accommodate the Work under this and other Sections, and attaching to miscellaneous metal fabrications all items such as sleeves, bands, studs, fasteners, and all items required for which provision is not specifically included under other Sections.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the Work to be installed with, or attached to miscellaneous metal fabrications Work.
2. Hot-dip Galvanizing: Coordinate with steel fabricator detailing for and fabrication of assemblies to be hot-dip galvanized, to minimize distortion during galvanizing process.

C. Related Sections:

1. Section 03 00 05 Concrete
2. Section 05 05 33, Anchor Systems.
3. Section 09 91 00, Painting,

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI A14.3, Ladders – Fixed –Safety Requirements.
2. ANSI Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
3. ASTM A36/A36M, Specification for Carbon Structural Steel.
4. ASTM A53/A53M, Specification for Pipe Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
5. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
6. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
7. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.
8. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
9. ASTM A384/A384M-02 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.

10. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
12. ASTM A793, Specification for Rolled Floor Plate, Stainless Steel.
13. ASTM A992/A992M, Specification for Structural Steel Shapes.
14. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
15. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire.
16. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
18. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. ASTM B632/B632M, Specification for Aluminum-Alloy Rolled Tread Plate.
20. AWS D1.1/D1.1M, Structural Welding Code – Steel.
21. AWS D1.2/D1.2M, Structural Welding Code – Aluminum.
22. AWS D1.6, Structural Welding Code – Stainless Steel.
23. NAAMM, Metal Finishes Manual.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Welding:
 - a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, D1.2/D1.2M, or D1.6, as applicable.
 - b. When requested by ENGINEER, provide certification that each welder employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.
2. Professional engineer:
 - a. CONTRACTOR shall retain a registered professional engineer legally qualified to practice in the same state as the Site to design miscellaneous metal fabrications as indicated in the Contract Documents.
 - b. Responsibilities include but are not necessarily limited to:
 - 1) Reviewing performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising preparation of design calculations and related Shop Drawings.
 - 4) Signing and sealing all design calculations and Shop Drawings.
 - 5) Certifying that:
 - a) Design has been performed in accordance with performance and design criteria stated in the Contract Documents, and
 - b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice

- B. Regulatory Requirements: Conform to the following:
 - 1. 29 CFR 1910, Occupational Health and Safety Standards.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Fabrication and erection details for assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for locating and installing miscellaneous metal items and anchorage devices. Provide signed and sealed shop drawing and design calculations by a Professional Engineer registered in the state in which the miscellaneous metal work will be installed and is a recognized expert in the type of Work shown and specified.
 - 2. Product Data:
 - a. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.
- B. Informational Submittals: Submit the following:
 - 1. Test and Evaluation Reports:
 - a. Mill test report that indicate chemical and physical properties of each type of material, when requested by ENGINEER.
 - 2. Qualifications Statements:
 - a. Copies of welder's certifications, when requested by ENGINEER.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in other construction in ample time to prevent delaying the Work.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Steel:
 - 1. W-Shapes and WT-Shapes: ASTM A992/A992M.
 - 2. S-Shapes and Channels: ASTM A572/A572M, Grade 50.
 - 3. Hollow Structural Sections: ASTM A500, Grade B.
 - 4. Angles, Plates, Bars: ASTM A36/A36M.
 - 5. Steel Pipe: ASTM A53/A53M, Grade B.
- B. Aluminum:
 - 1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B 221, Alloy 6061-T6.
 - 2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
 - 3. Aluminum Bars and Rod: ASTM B211, Alloy 6061-T6.
 - 4. Aluminum Plates: ASTM B209, Alloy 6061-T6.

- C. Stainless Steel:
 - 1. Plates and Sheets: ASTM A240/A240M, Type 316 stainless steel.
 - 2. Submerged or Intermittently Submerged: Type 316 stainless steel.
 - 3. Non-submerged: Type 316 stainless steel.
- D. Stainless Steel Fasteners and Fittings: ASTM A 320/A 320M, Type 316 Stainless Steel.
- E. Zinc-coated Hardware: ASTM A153/A153M.

2.2 MISCELLANEOUS METAL ITEMS

- A. Shop Assembly:
 - 1. Pre-assemble items in the shop to the greatest extent possible to minimize field-splicing and field-assembly of units at the Site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Shelf Angles:
 - 1. Provide structural steel shelf angles of sizes shown, for attachment to concrete or masonry construction. Provide slotted holes to receive 3/4-inch bolts, spaced not more than six inches from ends and not more than 1.0 feet on centers, unless otherwise shown.
 - a. Provide galvanized shelf angles on outdoor construction.
 - 2. Provide wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.
- C. Miscellaneous Framing and Supports:
 - 1. Provide miscellaneous metal framing and supports that are not part of structural steel framework and are required to complete the Work.
 - 2. Fabricate miscellaneous units to sizes, shapes, and profiles shown on the Drawings or, if not shown, of required dimensions to receive adjacent grating, plates, tanks, doors, and other work to be retained by the framing.
 - 3. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all-welded construction using mitered corners, welded brackets, and splice plates and minimum number of joints for field connection.
 - 4. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
 - 5. Furnish units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units are to be installed after concrete is placed.
 - a. Except as otherwise shown, space anchors, 2.0 feet on centers, and provide units the equivalent of 1.25-inch by 1/4-inch by eight-inch strips.
 - b. Galvanize exterior miscellaneous frames and supports.
 - c. Where shown or indicated, galvanize miscellaneous frames and supports that are not to be installed outdoors.
 - 6. Miscellaneous steel framing and supports shall be hot-dip galvanized and finish-painted, unless otherwise shown or indicated.
 - 7. Surface preparation and painting of galvanized surface shall conform to Section 09 91 00, Painting

- D. Fasteners and Hardware: Provide Type 316 stainless steel fasteners for aluminum fabrications and zinc-coated hardware for galvanized fabrications, unless otherwise shown or specified.
- E. Anchors and Expansion Anchors: Refer to Section 05 05 33, Anchor Systems.

2.3 FINISHING

- A. Surface Preparation and Shop Priming: Perform surface preparation and apply primer coat to miscellaneous metal fabrications in the shop. Conform to surface preparation and shop priming requirements in Section 09 91 00, Painting.
- B. Galvanizing:
 - 1. Galvanizing of fabricated steel items shall comply with ASTM A123/A123M.
 - 2. Details of fabrication of steel items and assemblies to be hot-dip galvanized shall conform to recommendations of ASTM A384/A384M to minimize the potential for distortion.
- C. Aluminum Finish: Provide an Architectural Class 1 anodized finish, AA-M32C22-A41, Clear, as specified in NAAMM Metal Finishes Manual.

2.4 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures complying with the Contract Documents.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which the Work is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install miscellaneous metal fabrications accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry, or other construction.
- B. Anchor securely as shown and as required for the intended use, using concealed anchors where possible.
- C. Fit exposed connections accurately together to form tight, hairline joints. Field-weld steel connections that are not to be exposed joints and cannot be shop-welded because of shipping size limitations. Comply with AWS D1.1/D1.1M, D1.2/D1.2M and D1.6, as applicable to the material being welded. Grind steel

joints smooth and touch-up shop paint coat. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Protection of Aluminum from Dissimilar Materials:

1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 91 00, Painting.

+ + END OF SECTION + +

SECTION 05 54 63

FLOOR ACCESS HATCH COVERS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install floor access hatch covers.
 - 2. The Work also includes:
 - a. Providing openings in and attachments to floor access hatch covers to accommodate the Work under this and other Sections, and providing for floor access hatch covers items such as anchorage devices, and all items required for which provision is not specifically included under other Sections.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items to be installed with or before floor access hatch covers Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.

1.2 REFERENCES

- A. Standards referenced in this Section:
 - 1. AASHTO Standard Specifications for Highway Bridges.
 - 2. MIL-P-21035B, Military Specification, Paint, High Zinc Dust Content Galvanizing Repair.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Manufacturer shall have not less than five years experience producing products substantially similar to those specified and, upon ENGINEER's request, shall submit documentation of not less than five satisfactory installations in place for not less than five years each.
- B. Component Supply and Compatibility:
 - 1. Obtain all products included in this Section regardless of the component manufacturer from a single floor access hatch covers manufacturer. Furnishing covers from more than one manufacturer is unacceptable.
 - 2. Floor access hatch covers manufacturer shall prepare, or shall review and approve, all Shop Drawings and other submittals for all components furnished under this Section.

3. Components shall be suitable for specified service conditions and shall be integrated into the overall assembly by the floor access hatch covers manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Detailed plans and other drawings showing location of products and direction of door swing; floor access hatch cover schedules indicating cover location, material, type, loading capacity, and other information; and fabrication details for the access hatch covers Work, including materials, thickness of metals, finishes, latching or locking provisions, type of anchorages, and accessory items.
 2. Product Data:
 - a. Copies of manufacturer's literature and specifications for each type of floor access hatch incorporated in the Work.
- B. Informational Submittals: Submit the following:
 1. Supplier Instructions:
 - a. Installation data, including setting drawings and templates.
 2. Qualifications Statements:
 - a. Manufacturer, when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping:
 1. Protect mill finish and other finish during shipping and installation by an attached, adhesive-backed vinyl material that is removable during and after installation of the access hatch cover.
- B. Storage and Protection:
 1. Protect steel members and packaged materials from corrosion and deterioration.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
- B. Special Warranty:
 1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace structural components of the products specified in this Section found to have defect in material and workmanship during a period of five years after the date of Substantial Completion.

PART 2 – PRODUCTS

Home Depot MPS and FM
Floor Access Hatch Covers
30036073

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2.1 GENERAL

A. General:

1. Provide manufacturer's standard fabricated access hatch cover units, modified when necessary to comply with the Contract Documents. Where standard units are not available for the sizes and types required, provide custom-fabricated units of the same quality as manufacturer's similar standard-sized units.
2. Fabricate each access hatch cover unit in the shop, complete with anchors, gaskets, hardware, and accessory items, as required.
3. Galvanizing Repair Paint: For repairing damaged galvanized surfaces, provide high zinc-dust content paint complying with MIL-P-21035B.

2.2 CHANNEL-FRAME TYPE ACCESS HATCH COVERS

A. Aluminum Floor Access Hatch Covers – Channel Frame Type:

1. Design Live Load: 300 pounds per square foot.
2. Products and Manufacturers: Provide one of the following:
 - a. Single-Leaf Door Aluminum Access Hatch Cover:
 - 1) Model TPS, by U.S.F Fabrication, Inc.
 - 2) Type J-AL, by The Bilco Company.
 - 3) Or approved equal.
 - b. Double-Leaf Door Aluminum Access Hatch Cover:
 - 1) Model TPD, by U.S.F. Fabrication, Inc.
 - 2) Type JD-AL, by The Bilco Company.
 - 3) Or approved equal.
3. Cover: Not less than 1/4-inch thick, aluminum diamond-pattern plate cover. Provide flush drop-handle for lifting the cover.
4. Frame: Extruded aluminum channel frame with manufacturer's standard anchor tabs or continuous anchor flange around perimeter for anchorage to concrete.
5. Drain Coupling: 1.5-inch diameter NPT threaded drain coupling welded under the channel frame for connection of a drain pipe.
6. Gasket: EPDM gasket mechanically attached to the channel frame.
7. Hinges: Type 316 stainless steel, heavy-duty butt hinges with Type 316 stainless steel pin fastened to door with Type 316 stainless steel tamper-resistant bolts.
8. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
9. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.
10. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
11. Finish: Mill finish.

- B. Provide Schedule 40 PVC drain piping from the floor access hatch cover channel frame routed as indicated in the Contract Documents.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which floor access hatch cover Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install floor access hatch covers in accordance with approved Shop Drawings and other approved submittals, the Contract Documents, and manufacturer's instructions.
- B. Set floor access hatch covers level and true to line or grade, without warp or rack.
- C. Protection of Aluminum from Dissimilar Materials: Coat surfaces of aluminum in contact with dissimilar materials such as concrete, masonry, steel, and other metals in accordance with Section 09 91 00, Painting.

3.3 ADJUSTING AND CLEANING

- A. Adjust leafs of floor access hatch covers as necessary to provide proper operations.
- B. Remove stains, concrete splatter, oils, grease, and other foreign materials necessary and provide clean, finished surfaces.

+ + END OF SECTION + +

SECTION 07 92 00

JOINT SEALANTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install joint sealants.
2. Extent of each type of calking and sealant is shown or indicated and includes the following:
 - a. Interior and exterior joints in equipment and construction systems not filled by another material, and that are not required to be open for operation.
 - b. Joints specified to be recalked.

B. Coordination:

1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before joint sealants.
2. Coordinate final selection of joint sealants so that materials are compatible with all calking and sealant substrates specified.

C. Related Sections:

1. Section 03 00 05, Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ASTM C510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
2. ASTM C661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
3. ASTM C793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
4. ASTM C794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
5. ASTM C920, Specification for Elastomeric Joint Sealants.
6. ASTM C1021, Practice for Laboratories Engaged in Testing Building Sealants.
7. ASTM C1087, Test method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
8. ASTM C1193, Guide for Use of Joint Sealants.
9. ASTM C1247, Practice for Durability of Sealants Exposed to Continuous Immersion in Liquids.
10. BAAQMD Regulation 8, Rule 51.
11. FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
12. FS TT-S-00230 Sealing Compound: Elastomeric Type, Single Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
13. NSF/ANSI Standard 61, Drinking Water System Components - Health Effects.

14. SCAQMD Rule 1168.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installer:
 - a. Engage a single installer, approved by product manufacturer, regularly engaged in calking and sealant installation and with successful experience in applying types of products required, and who employs only tradesmen with specific skill and successful experience in the type of Work required.
 - 2. Testing Laboratory:
 - a. Furnish services of independent testing laboratory qualified according to ASTM C1021, for conducting testing required.
- B. Component Supply and Compatibility:
 - 1. Obtain materials only from manufacturers who will, if required:
 - a. Furnish at the Site services of a qualified technical representative to advise installer of proper procedures and precautions for using materials.
 - b. Test joint sealants for compatibility with substrates for conformance with FS-TT-S-00227, and recommend remedial procedures as required.
 - 2. Before purchasing each sealant, investigate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer's published data or certification, and as shown on approved Shop Drawings and other approved submittals.
- C. Product Testing: Provide test results of laboratory pre-construction compatibility and adhesion testing, as specified in Article 3.1 of this Section, by qualified testing laboratory, based on testing of current sealant formulations within a 36-month period preceding the Notice to Proceed for the Work.
 - 1. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920 and, where applicable, to other standard test methods.
 - 2. Test other joint sealants for compliance using specified post-construction field adhesion test.
- D. Mock-ups:
 - 1. Prior to installing joint sealant Work but after ENGINEER's approval of Samples, provide Sample of each type of calking and sealant in areas selected by ENGINEER to show representative installation of calkings and sealants. Obtain ENGINEER's approval of visual qualities of mock-ups before starting calking and sealant Work. Retain and protect mock-ups during construction as a standard for judging completed calking and sealant Work. Do not alter or destroy mock-ups until so allowed by ENGINEER.
 - 2. Perform the following testing on calking and sealant mock-up, as specified in this Section: Post-construction field adhesion testing and water leak test.
 - 3. Work that does not comply with test requirements on Sample areas will be considered defective.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Schedule of joint sealants installation, indication each specific surface where calking or sealants are to be provided and the material proposed for each application.
 - 2. Product Data:
 - a. Copies of manufacturer's data sheets including color charts, specifications, recommendations, and installation instructions for each type of sealant, calking compound, and associated miscellaneous material required. Include manufacturer's published data, indicating that each product complies with the Contract Documents and is intended for the applications shown or indicated.
 - b. Product test reports.
 - 3. Samples:
 - a. Each type of actual cured material of each calking and sealant specified, in each of manufacturer's standard colors.
 - b. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is responsibility of CONTRACTOR.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certify that materials are suitable for intended use and materials meet or exceed requirements of the Contract Documents.
 - b. Certification from manufacturer that products furnished are appropriate for surfaces and conditions to which they will be applied.
 - c. Certify that applicator is approved by manufacturer.
 - 2. Field Quality Control Submittals:
 - a. Results of tests on job mock-ups.
 - b. Pre-construction and post-construction field test reports.
 - c. Compatibility and adhesion test reports.
 - d. Contractor's Field Test Report Logs:
 - 1) Indicate time present at the Site.
 - 2) Include observations and results of field tests, and document compliance with manufacturer's installation instructions and supplemental instructions provided to installers.
 - 3. Qualifications: Submit qualifications for:
 - a. Installer.
- C. Closeout Submittals: Submit the following:
 - 1. Operation and Maintenance Data:
 - a. Recommended inspection intervals.
 - b. Instructions for repairing and replacing failed sealant joints.
 - 2. Warranty: Submit written warranties as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with the following:
 - 1. Delivery of Products:
 - a. Deliver products in calking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.

- b. Include the following information on label:
 - 1) Name of material and Supplier.
 - 2) Formula or Specification Section number, lot number, color and date of manufacture.
 - 3) Mixing instructions, shelf life, and curing time, when applicable.
- 2. Storage of Products:
 - a. Do not store or expose materials to temperature above 90 degrees F or store in direct sunlight.
 - b. Do not use materials that are outdated as indicated by shelf life.
 - c. Store sealant tape in manner that will not deform tape.
 - d. In cool or cold weather, store containers for sixteen hours before using in temperature of approximately 75 degrees F.
 - e. When high temperatures prevail, store mixed sealants in a cool place.
- 3. Handling:
 - a. Do not open containers or mix components until necessary preparatory Work and priming are complete.

1.6 JOB CONDITIONS

- A. Environmental Conditions:
 - 1. Do not install joint sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
 - 2. Proceed with the Work when forecasted weather conditions are favorable for proper cure and development of high-early bond strength.
 - 3. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
 - 4. When high temperatures prevail, avoid mixing sealants in direct sunlight.
 - 5. Supplemental heat sources required to maintain both ambient and surface temperatures within the range recommended by manufacturer for material applications are not available at the Site.
 - 6. Provide supplemental heat and energy sources, power, equipment, and operating, maintenance, and temperature monitoring personnel.
 - 7. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas of calking, sealants, and painting Work, and areas where OWNER's personnel or construction personnel may work. Properly locate and vent such heat sources to outdoors so that joint sealants and other Work are unaffected by exhaust.

1.7 WARRANTY

- A. Provide written warranty, signed by manufacturer and CONTRACTOR, agreeing to repair or replace sealants that fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified in approved Shop Drawings and other submittals, as an inherent quality of material for exposure indicated.
 - 1. Provide manufacturer warranty for period of one year from date of Substantial Completion of joint sealants Work.

2. Provide installer warranty for period of two years from date of Substantial Completion of joint sealants Work.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Provide elastomeric joint sealants for interior and exterior joint applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide colors selected by ENGINEER from calking and sealant manufacturer's standard and custom color charts. "Or approved equal" manufacturers shall provide same generic products and colors as available from manufacturers specified.

2.2 MATERIALS

- A. Exterior and Interior Horizontal and Vertical Joints; Submerged and Intermittently Submerged in Wastewater:
 1. Two-component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c NS by Sika Corporation.
 - 2) Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or equal.
 - b. Polyurethane based, two-component elastomeric sealant complying with:
 - 1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
 - 2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 18 lbs.
 - 3) Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
 - 4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
 - 7) VOC Content: 220 grams per liter, maximum.
- B. Exterior and Interior Vertical Joints; Non-submerged:
 1. Two-component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c NS by Sika Corporation.
 - 2) Dymeric 240 FC by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or approved equal.
 - b. Polyurethane based, two-component elastomeric sealant complying with:
 - 1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
 - 2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 10 pounds.

- 3) Hardness (Standard Conditions), ASTM C661: 25 to 35 (Shore A).
 - 4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
 - 7) VOC Content: 100 g/L, maximum.
- C. Exterior and Interior Horizontal Joints; Non-submerged:
1. Two-component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c SL by Sika Corporation.
 - 2) THC/900 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or approved equal.
 - b. Polyurethane based, two-component elastomeric, self-leveling sealant complying with the following:
 - 1) FS TT-S-00227E, Type I (self-leveling) Class A. and ASTM C920, Type M, Grade P, Class 25
 - 2) Water Immersion Bond, FS TT-S-00227E: Elongation of 50 percent with no adhesive failure.
 - 3) Hardness (Standard Conditions), ASTM C661: 35 to 45.
 - 4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) VOC Content: 165 g/L, maximum.
- D. Miscellaneous Materials:
1. Joint Cleaner: As recommended by calking and sealant manufacturer.
 2. Joint Primer and Sealer: As recommended for compatibility with calking and sealant by calking and sealant manufacturer.
 3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended for compatibility with calking and sealant by calking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of calking and sealant. Provide self-adhesive tape where applicable.
 4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with calking and sealant by calking and sealant manufacturer. Provide size and shape of rod that will control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide highly-compressible backer to minimize possibility of sealant extrusion when joint is compressed.
 5. Low-temperature Catalyst: As recommended by calking and sealant manufacturer.

PART 3 – EXECUTION

3.1 INSPECTION

Home Depot MPS and FM
 Joint Sealants
 30036073

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- A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and conditions under which calking and sealant Work will be performed, and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work and performance of sealants. Do not proceed with calking and sealant Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Protection: Do not allow joint sealants to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or calking and sealant materials.
- B. Joint Surface Preparation:
 - 1. Clean joint surfaces immediately before installing sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances that would interfere with bonds of sealant compound as recommended in sealant manufacturer's written instructions as shown on approved Shop Drawings.
 - 2. If necessary, clean porous materials by grinding, sandblasting, or mechanical abrading. Blow out joints with oil-free compressed air or by vacuuming joints prior to applying primer or sealant.
 - 3. Roughen joint surfaces on vitreous coated and similar non-porous materials, when sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.
 - 4. Concrete Joint Preparation: Refer to Section 03 00 05, Concrete
- C. Mixing:
 - 1. Comply with sealant manufacturer's written instructions for mixing multi-component sealants.
 - 2. Thoroughly mix components before use.
 - 3. Add entire contents of activator can to base container. Do not mix partial units.
 - 4. Mix contents for minimum of five minutes or as recommended by sealant manufacturer, until color and consistency are uniform.

3.3 INSTALLATION

- A. Install joint sealants after adjacent areas have been cleaned and before joint has been cleaned and primed, to ensure calking and sealant joints will not be soiled. Replace calking and sealant joints soiled after installation.
- B. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or indicated in the Contract Documents, and except where manufacturer's technical representative directs otherwise, only as acceptable to ENGINEER.
- C. Prime or seal joint surfaces as shown on approved Shop Drawings and approved other submittals. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to applying sealants.

- D. Apply masking tape before installing primer, in continuous strips in alignment with joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.
- E. Do not install sealants without backer rods and bond breaker tape.
- F. Roll back-up rod stock into joint to avoid lengthwise stretching. Do not twist, braid, puncture, or prime backer rods.
- G. Employ only proven installation techniques that will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- H. Install sealants to depths recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of bead.
 - 1. For horizontal joints in sidewalks, pavements, and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
 - 2. For vertical joints subjected to normal movement and sealed with elastomeric sealants and not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.
- I. Remove excess and spillage of compounds promptly as the Work progresses.
- J. Cure calking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high-early bond strength, internal cohesive strength, and surface durability.

3.4 EXISTING JOINTS

- A. Mechanically remove existing sealant and backer rod.
- B. Clean joint surfaces of residual sealant and other contaminants capable of affecting sealant bond to joint surface.
- C. Conduct laboratory pre-construction compatibility and adhesion testing on joint surfaces in accordance with Paragraph 3.1.B of this Section.
- D. Allow joint surfaces to dry before installing new sealants.

3.5 FIELD QUALITY CONTROL

- A. Post-construction Field Adhesion Testing: Before installing elastomeric sealants, field-test joint sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed elastomeric sealant joints as follows:

- a. Perform ten tests for the first 1,000 feet of joint length for each type of elastomeric sealant and joint substrate.
- b. Perform one test for each 1,000 feet of joint length thereafter, and minimum of one test per each floor per elevation.
- c. Test Method: Test joint sealants according to Method A, Field-applied Sealant Joint Hand Pull Tab, and Method D, Water Immersion in Appendix X1 of ASTM C1193. For joints with dissimilar substrates, verify adhesion to each substrate separately by extending cut along one side and verifying adhesion to opposite side. Repeat procedure for opposite side.
- d. Inspect joints for complete fill, absence of voids, and joint configuration complying with specified requirements. Record results in a log of field adhesion tests.
- e. Inspect tested joints and report on whether:
 - 1) Sealants in joints 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. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 - 2) Sealants filled the joint cavities and are free of voids.
 - 3) Sealant dimensions and configurations comply with specified requirements.
- f. Record test results in a log of field adhesion tests. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
- g. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- h. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other requirements will be satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
- i. Do not proceed with installation of elastomeric sealants over joint surfaces that have been painted, lacquered, waterproofed, or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227, has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

B. Water Leak Testing: Field test for water leaks as follows:

1. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, two feet from joint and connected to water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.
2. Test approximately five percent of total joint system, in locations that are typical of every joint condition, and that can be inspected easily for

leakage on opposite face. Conduct test in presence of ENGINEER, who will determine actual percentage of joints to be tested and actual period of exposure to water from hose, based on extent of observed leakage or lack of observed leakage.

3. Where nature of observed leaks indicates potential of inadequate joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion.

3.6 ADJUSTING AND CLEANING

- A. Where leaks and lack of adhesion are evident, replace sealant.
- B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by sealant manufacturer. Leave all finish Work in neat, clean condition.
- C. Protect sealants during construction so that they will be without deterioration, soiling, or damage at time of readiness for final payment of the Contract.

3.7 PROTECTION

- A. During and after curing period, protect joint sealants 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.

+ + END OF SECTION + +

SECTION 09 91 00

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and apply paint systems.
 - a. CONTRACTOR is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included under this and other Sections.
2. Extent of painting includes the Work specified below. Painting shown on Drawings or described in this Section may not provide CONTRACTOR with complete indication of all painting Work. Refer to Article 2.2 of this Section where all surfaces of generic types specified are specified for preparation and painting according to their status, intended function, and location, using the painting system for that surface, function, and location as specified, unless specifically identified on the Drawings as a surface not to receive specified painting system.
 - a. All new and specifically identified existing surfaces and items except where natural finish of material is specified as a corrosion-resistant material not requiring paint; or is specifically shown as indicated by written note or specified as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.
 - b. Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by OWNER, are included in the Work, except as otherwise shown or specified.
 - c. Removal of all substances, topcoats, primers and all intermediate coats of paint and other protective or decorative coatings on those items and surfaces to remain that are identified to receive a painting system under this Section, to provide surfaces acceptable for application of painting specified.

B. Coordination:

1. Review installation, removal, and demolition procedures under other Sections and coordinate them with the Work specified in this Section.
2. Coordinate painting of areas that will become inaccessible once equipment and similar fixed items have been installed.
3. Furnish information to ENGINEER on characteristics of finish materials proposed for use and ensure compatibility with prime coats used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify ENGINEER in writing of anticipated problems using specified painting systems with surfaces primed by others. Reprime equipment primed in factory and other factory-primed items that are damaged or scratched.

- C. Work Not Included: The following Work is not included as painting Work, or are included under other Sections:
1. Shop Priming: Shop priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-painted process equipment, plumbing equipment, heating and ventilating equipment, electrical equipment, and accessories shall conform to applicable requirements of this Section but are included under other Sections.
 2. Pre-finished Items:
 - a. Items furnished with such finishes as baked-on enamel, porcelain, and polyvinylidene fluoride shall only be touched up at Site by CONTRACTOR using manufacturer's recommended compatible field-applied touchup paint.
 - b. Items furnished with finishes such as chrome plating or anodizing.
 3. Concealed Surfaces: Non-metallic wall or ceiling surfaces in areas not exposed to view, and generally inaccessible areas, such as furred spaces, pipe chases, duct shafts, and elevator shafts.
 4. Concrete floors, unless specifically shown as a surface to be painted.
 5. Face brick, glazed structural tile, and prefaced, ground-faced or split-faced concrete unit masonry.
 6. Exterior face of architectural precast concrete.
 7. Collector bearings, shafts and chains, wood flights, wood stop logs, and wood or fiberglass baffles.
 8. Corrosion-Resistant Metal Surfaces: Where the natural oxide of item forms a barrier to corrosion, whether factory- or Site-formed, including such materials as copper, bronze, muntz metal, terne metal, and stainless steel.
 9. Operating Parts and Labels:
 - a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors, and fan shafts.
 - b. Do not paint over labels required by governing authorities having jurisdiction at Site, or equipment identification, performance rating, nameplates, and nomenclature plates.
 - c. Cover moving parts and labels during the painting with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings, and splatter that comes in contact with such labels.
 10. Structural and miscellaneous metals covered with concrete need not receive primers, intermediate, or finish coats of paint.
- D. Description of Colors and Finishes:
1. Color Selection:
 - a. OWNER reserves the right to select non-standard colors for paint systems specified within ability of paint manufacturer to produce such non-standard colors. Provide such colors at no additional expense to OWNER.
 2. Color Coding of Pipelines, Valves, Equipment, and Ducts:
 - a. Color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1, CFR 1910.144, Recommended Standards for Water Works, and Recommended Standards for Wastewater Facilities. For piping and equipment not covered by the above standards, conform to

- OWNER's painting color, system, and thickness standards, where applicable.
- b. For equipment located on roofs and equipment that is exposed-to-view, color will be selected by OWNER.

1.2 REFERENCES

- A. Referenced Standards: Standards referenced in this Section are:
 - 1. ANSI A13.1, Scheme for Identification of Piping Systems.
 - 2. ANSI Z535.1, Safety Color Code.
 - 3. ASTM D16, Terminology for Paint, Related Coatings, Materials and Applications.
 - 4. ASTM D2200, Pictorial Surface Preparation Standards for Painting Steel Surfaces.
 - 5. ASTM D4262, Testing Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
 - 6. ASTM D4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - 7. ASTM D4541, Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
 - 8. ASTM E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
 - 9. Great Lakes Upper Mississippi River Board of Public Health and Environmental Managers (GLUMRB) Recommended Standards for Water Works.
 - 10. GLUMRB, Recommended Standards for Wastewater Facilities.
 - 11. Ozone Transport Commission, (OTC), OTC Model Rule for Architectural and Industrial Maintenance Coatings.
 - 12. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
 - 13. SSPC VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
 - 14. SSPC VIS 2, Method of Evaluating Degree of Rusting/Painted Steel Surfaces.
 - 15. SSPC Volume 2, Systems and Specifications.

1.3 DEFINITIONS

- A. Coating terms defined in ASTM D16 apply to this Section.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications:
 - 1. Engage a single applicator regularly performing installation of painting systems, with documented skill and successful experience in installing types of products required and agrees to employ only tradesmen trained, skilled, and with successful experience in installing types of products specified.
- B. Testing Agency Qualifications: Provide independent testing agency with experience and capability to satisfactorily conduct testing specified in accordance with ASTM E329. Testing agency shall be selected by OWNER and paid for by CONTRACTOR.
- C. Source Quality Control:

1. Obtain products from manufacturers that will provide services of a qualified manufacturer's representative at Site at commencement of painting Work to advise on products, mock-ups, installation, and finishing techniques, at completion of the Work to advise ENGINEER on acceptability of completed Work, and during course of Work as requested by ENGINEER.
2. Submit "or equal" products, when proposed, with direct comparison to products specified, including information on durability, adhesion, color and gloss retention, percent solids, VOC's grams per liter, and re-coatability after curing.
3. "Or equal" manufacturers shall furnish same color selection as manufacturers specified, including intense chroma and custom pigmented colors in painting systems.
4. Color Pigments: Provide pure, non-fading, applicable types to suit surfaces and services indicated. Comply with the following:
 - a. Lead and Chromate: Lead and chromate content shall not exceed amount allowed by authorities having jurisdiction.
 - b. Through CONTRACTOR, paint manufacturer shall notify ENGINEER of colors that are not suitable for long-term color retention in areas subject to hydrogen sulfide fume exposure.
 - c. Manufacturer shall identify colors that meet requirements of authorities having jurisdiction at Site for use in locations subject to contact with potable water or water that will be treated to become potable.
 - d. Comply with paint manufacturers' recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint coatings.

D. Regulatory Requirements:

1. Comply with VOC content limits of Ozone Transport Commission (OTC), Model Rule for Architectural and Industrial Maintenance Coatings.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Copies of manufacturer's technical data sheets, including surface preparation, number of coats, dry film thickness, test performance data including paint analysis, VOC and chemical component content in comparison to maximum allowed by the Contact Documents, and application instructions for each product proposed for use
 - b. Submit proof of acceptability of proposed application techniques by paint manufacturer selected.
 - c. Copies of CONTRACTOR's proposed protection procedures in each area of the Work explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption, and for maintaining acceptable application, curing, and environmental conditions during and after painting systems application.

- d. List each material and cross-reference to the specific painting system and application, including a list of site-specific surfaces to which painting system will be applied. Identify by manufacturer's catalog number and general classification. State number of gallons of each product being purchased for delivery to Site and square foot area calculated to be covered by each painting system specified based on theoretical loss of 20 percent. Where actual area to be covered by paint system exceeds area submitted to ENGINEER for that system, proof of additional material purchase shall be provided to ENGINEER. Calculated coverage shall be as specified for each component of each painting system specified. This requirement does not take precedence over CONTRACTOR's responsibility to provide dry film thickness required for each component of each painting system.
 - e. Identify maximum exposure times allowable for each paint system component before next coat of paint can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.
 - f. Information on curing times and environmental conditions that affect curing time of each paint system component and proposed methods for accommodating variations in curing time. Identify this information for each painting system in the Work.
 - g. Specification for spray equipment with cross-reference to paint manufacturer's recommended equipment requirements.
2. Samples:
- a. Copies of manufacturer's complete color charts for each coating system.
- B. Informational Submittals: Submit the following:
- 1. Certificates:
 - a. Certificate from paint manufacturer stating that materials meet or exceed Contract Documents requirements.
 - b. CONTRACTOR shall provide notarized statement verifying that all painting systems are compatible with surfaces specified. All painting systems components shall be reviewed by an authorized technical representative of paint manufacturer for use as a compatible system. Verify that all painting systems are acceptable for exposures specified and that paint manufacturer is in agreement that selected systems are proper, compatible, and are not in conflict with paint manufacturer's recommended specifications. Show by copy of transmittal form that a copy of letter has been transmitted to paint applicator.
 - 2. Test Reports:
 - a. Certified laboratory test reports for required performance and analysis testing in compliance with ASTM E329.
 - b. Adhesion testing plan and procedures.
 - c. Results of adhesion testing on existing surfaces containing paints or other coatings to be top coated with paint systems specified. Prior to adhesion testing, submit a testing plan establishing methods, procedures and number of tests in each area where existing coatings are to remain and become substrate for painting Work. Based on results of adhesion testing, recommend methods,

- procedures, and painting system modifications, if necessary, for proceeding with Work.
- d. Locations of and test methods for soil sampling before beginning Work and after Substantial Completion.
- e. Proposed methods for testing, handling, and disposal of waste generated during Work.
- f. Results of alkalinity and moisture content tests performed per ASTM D4262 and ASTM D4263.
- g. Results of film thickness, holidays, and imperfections tests.
- 3. Manufacturer's Instructions: Provide paint manufacturer's storage, handling, and application instructions prior to commencing painting Work at Site.
- 4. Manufacturer's Site Reports: Provide report of paint manufacturer's representative for each visit to Site by paint manufacturer's representative.
- 5. Special Procedure Submittals:
 - a. Proposed protection procedures for each area of Work, explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption.
 - b. Site-specific health and safety plan.
 - c. Procedures for maintaining acceptable application, curing and environmental conditions during and after painting systems application.
 - d. Procedures for providing adequate lighting, ventilation, and personal protection equipment relative to painting Work.
- 6. Qualifications:
 - a. Applicator.
 - b. Testing laboratory
- C. Closeout Submittals: Submit the following:
 - 1. Maintenance Manual: Upon completion of the painting Work, furnish ENGINEER five copies of detailed maintenance manual including the following information:
 - a. Complete and updated product catalog of paint manufacturer's currently available products including complete technical information on each product. Identify product names and numbers of each product used in the painting Work.
 - b. Name, address, e-mail address and telephone number of manufacturer, local distributor, applicator and technical representative.
 - c. Detailed procedures for routine maintenance and cleaning.
 - d. Detailed procedures for light repairs such as dents, scratches and staining.
 - 2. Statement of Application: Upon completion of the painting Work, submit a notarized statement to ENGINEER signed by CONTRACTOR and painting applicator stating that Work complies with requirements of the Contract Documents and that application methods, equipment, and environmental conditions were proper and adequate for conditions of installation and use.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Product Delivery Requirements: Deliver products to Site in original, new, and unopened packages and containers, accurately and legibly and accurately labeled with the following:
 - 1. Container contents, including name and generic description of product.
 - 2. Manufacturer's stock number and date of manufacture.
 - 3. Manufacturer's name.
 - 4. Contents by volume, for major pigment and vehicle constituents.
 - 5. Grams per liter of volatile organic compounds.
 - 6. Thinning instructions, where recommended.
 - 7. Application instructions.
 - 8. Color name and number.
- B. Product Storage Requirements:
 - 1. Store acceptable materials at Site.
 - 2. Store in an environmentally controlled location as recommended in paint manufacturer's written product information. Keep area clean and accessible. Prevent freezing of products.
 - 3. Store products that are not in actual use in tightly covered containers.
 - 4. Comply with health and fire regulations of authorities having jurisdiction at Site.
- C. Product Handling Requirements:
 - 1. Handle products in a manner that minimizes the potential for contamination, or incorrect product catalyzation.
 - 2. Do not open containers or mix components until necessary preparatory work has been completed and approved by ENGINEER and painting Work will start immediately.
 - 3. Maintain containers used in storing, mixing, and applying paint in a clean condition, free of foreign materials and residue.

1.7 SITE CONDITIONS

- A. Site Facilities:
 - 1. Supplemental heat sources, as required to maintain both ambient and surface temperatures within range recommended by paint manufacturer for paint system applications, are not available at the Site.
 - 2. Provision of supplemental heat energy sources, power, equipment, and operating, maintenance, and temperature-monitoring personnel is CONTRACTOR's responsibility.
 - 3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent heat sources to exterior so that paint systems and personnel are unaffected by exhaust products.
- B. Existing Conditions:
 - 1. Existing surfaces to receive painting Work shall have their surfaces prepared to meet requirements of painting systems specified. Prior to initiating painting Work, perform adhesion tests on existing surfaces to be painted. Perform testing per ASTM D4541 or other method acceptable to ENGINEER. Number and location of tests shall be sufficient to determine the condition of existing coatings and suitability

- of existing coatings to remain to provide an acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER the adhesion test results.
2. Provide abrasive blasting, scraping, or other abrading or surface film removal, or preparatory techniques accepted by ENGINEER.
 3. Before commencing painting in an area, surfaces to be painted and floors shall be cleaned of dust using commercial vacuum cleaning equipment equipped with high-efficiency particulate air (HEPA) filters and dust containment systems.
 4. After painting operations have started in a given area, cleaning only with commercial vacuum cleaning equipment with high-efficiency particulate air (HEPA) filters and dust containment systems.
- C. Environmental Requirements:
1. Comply with manufacturer's published requirements.
- D. Protection:
1. Cover or otherwise protect finished Work of other trades and those surfaces not being painted concurrently and not to be painted.
 2. During surface preparation and painting, facility shall remain in operation. Use procedures that prevent contamination of process or cause or require facility shutdown.
 3. Coordinate and schedule surface preparation and painting to avoid exposing personnel to hazards associated with painting Work. Provide required personnel safety equipment per requirements of authorities having jurisdiction at Site.
 4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work until ENGINEER accepts protection techniques proposed by CONTRACTOR.
 5. When working with flammable materials, provide fire extinguishers and post temporary signs warning against smoking and open flame.

1.8 COMPONENTS REQUIRING COATING:

- A. The CONTRACTOR shall coat all the components described below. The list attempts to generally identify key components to be coated and the applicable coating system, but shall not be utilized as a basis for concluding that common sense extension of the overall intent is not applicable because an item is not specifically named. In general, exclusive of items identified herein not to be coated, all new facilities, equipment, and ferrous metal shall be coated.
- B. New Non-Submerged Metals and Miscellaneous Non-Metallic, Non-submerged Items (i.e., non-buried pipe, fittings, valves, supports, conduit (excluding aluminum), brackets, metal fabrications, etc.). All 304 SS, galvanized, aluminum, FRP, PVC, CPVC and copper surfaces shall be scarified and solvent cleaned per SSPC SP-1.
1. Above grade pipe, fittings, valves of all materials except 316 SS.
 2. Pipe supports, excluding 316 SS or aluminum.
 3. Structural members, including brackets and supports.
 4. All nuts, bolts and washers excluding 316 SS except on piping.
 5. Electric pull box covers.

6. All new non-buried, non-submerged ferrous, PVC, FRP, galvanized, 304 SS and aluminum surfaces not specifically excluded or named elsewhere.

PART 2 - PRODUCTS

2.1 PAINTING SYSTEM MANUFACTURERS

- A. Products and Manufacturers: Where referenced under painting systems, provide painting systems manufactured by the following:
 1. Tnemec Company, Incorporated (TCI).
 2. The Carboline Company, subsidiary of RPM International Inc (TCC).
 3. Sherwin-Williams Company (SWC).
 4. Or approved equal.

2.2 PAINTING SYSTEMS

- A. New Ferrous Metals, Structural Steel, Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Pumps, Exterior Surfaces of Ferrous Piping, and Exterior Surfaces of All Ferrous Metal; Non-submerged, Interior:
 1. Surface Preparation: Refer to section 3.2.
 2. Shop Primer:
 - a. Generic Components:
 - 1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC): One coat, 4.0 to 6.0 dry mils.
 3. Field Primer and Touch-Up:
 - a. Generic Components:
 - 1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC): One coat, 4.0 to 6.0 dry mils.
 4. Finish: High-Gloss:
 - a. Generic Components:
 - 1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC): One coat, 4.0 to 6.0 dry mils.
- B. New and Existing Ferrous Metals, Non-Ferrous Metals, and Galvanized Metals; Low VOC Content, Non-Submerged, Exterior:
 1. Surface Preparation: Refer to section 3.2.
 2. Ferrous Metal Primer:
 - a. Generic Components:

- 1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy coating; 250 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline II (TCI); Carboguard 890 LT (TCC); Macropoxy HS (SWC): One coat, 4.0 to 6.0 dry mils.
 3. Ferrous Metal Touch-Up:
 - a. Generic Components:
 - 1) Minimum 80 percent volume solids, modified polyamido-amine or polyamine epoxy; 296 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline II (TCI); Carboguard 1207 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 6.0 dry mils.
 4. Galvanized and Non-Ferrous Primer.
 - a. Generic Components:
 - 1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy coating; 250 grams per liter VOC, maximum .
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 890 LT (TCC); Macropoxy HS (SWC): One coat, 4.0 to 6.0 dry mils.
 5. Intermediate – Ferrous Metals Only:
 - a. Generic Components:
 - 1) Minimum 80 percent volume solids, modified polyamido-amine or polyamine epoxy; 296 grams per liter VOC, maximum .
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 1207 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 6.0 dry mils .
 6. Finish: Gloss:
 - a. Generic Components:
 - 1) Minimum 49 percent volume solids, two-component, waterborne acrylic polyurethane or aliphatic acrylic polyurethane coating; 247 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 1074 EnduraShield (TCI); Carbothane 134 VOC (TCC); Centurion WB Urethane (SWC): Two coats, 2.0 to 3.0 dry mils.
- C. New and Existing Galvanized Metal, Non-Ferrous Metal, and Fiberglass; Non-submerged, Interior:
1. Surface Preparation: Refer to section 3.2.
 2. Primer:
 - a. Generic Components:
 - 1) Minimum, 39 percent volume solids single-component, self-cross linking acrylic primer-sealer, 140 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 1026 Enduratone (TCI); Galoseal Wash Primer (TCC); Pro-Cryl Universal Primer (SWC): One coat, 2.0 to 4.0 dry mils.
 3. Finish: Satin:
 - a. Generic Components:
 - 1) Minimum, 41 percent volume solids, single component, self-cross linking acrylic; 208 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:

- 1) Series 1026 Enduratone (TCI); Carbocrylic 3359 (TCC); DTM Acrylic Coating (SWC): One coat, 2.0 to 4.0 dry mils.

- D. New and Existing Aluminum in Contact with Dissimilar Materials:
 1. Surface Preparation: Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.
 2. Primer/Finish:
 - a. Generic Components:
 - 1) Minimum 100 percent volume solids, high-build, two-component, polyamido-amine or polyamine epoxy; 49 grams per gallon VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC); Dura-Plate UHS (SWC): Two coats, 8.0 to 15.0 dry mils, per coat.
- E. New and Existing PVC and CPVC Piping and Fiberglass Insulation Covering; Non-submerged, Interior:
 1. Surface Preparation: Refer to section 3.2.
 2. Primer:
 - a. Generic Components:
 - 1) Minimum 37 percent volume solids single-component, self-cross linking acrylic primer-sealer; 226 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 1026 Enduratone DF (TCI); Carbocrylic 3358 (TCC); DTM Acrylic Primer/Finish (SWC): One coat, 2.0 to 4.0 dry mils.
 3. Finish: Satin:
 - a. Generic Components:
 - 1) Minimum 37 percent volume solids, single component, self-cross linking acrylic; 226 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 1026 Enduratone (TCI); Carbocrylic 3358 (TCC); DTM Acrylic Primer/Finish (SWC): Two coats, 2.0 to 4.0 dry mils.

2.3 CAULKING AND SEALANTS

- A. Refer to Section 07 92 00, Joint Sealants.

2.4 INSTRUMENTS

- A. Instruments:
 1. Provide one new dry-film thickness gauge for checking film thickness, one holiday detector to detect holidays or holes in the coating, and one set of visual standards to check surface preparation. Calibrate dry film thickness gauge at Site using Bureau of Standards standard shim blocks.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which painting Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for long-term adherence and durability of painting systems specified, or where paint manufacturer requires removal of all existing paint to recommend use of specified painting system.

3.2 SURFACE PREPARATION

- A. General:
 - 1. Perform preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as herein specified, for each particular substrate condition. When the specified and recommended manufacturer's surface preparation system differ, use the system which in the ENGINEER's opinion is the more restrictive (conservative). Do not apply any primer, first coat or subsequent coats until the ENGINEER has approved the surface preparation.
- B. Preparation:
 - 1. Carefully remove all hardware, hardware accessories, machine surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove if necessary, for the complete painting of the items and adjacent surfaces. Following completion of painting of each space or area, reinstall the removed items by workmen skilled in the trades involved.
- C. Cleaning:
 - 1. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program the cleaning and painting so that contaminants from the cleaning process will not fall onto wet, newly-painted surfaces.
- D. Compatibility:
 - 1. Confirm compatibility with substrates where existing facilities are to be recoated as part of this project. Scarify or otherwise prepare existing coated surfaces as recommended by the manufacturer and to the satisfaction of the ENGINEER.
- E. Ferrous Metals:
 - 1. All new ferrous surfaces shall be sand blasted to a "Near White, SSPC-SP10" condition as specified by the Steel Structures Painting Council. Coatings shall be applied to all blasted surfaces before surface oxidation appears, but in any case, prior to the end of the same workday on which the blasting occurred.
 - 2. New pumps, motors, or similar equipment shall be shop primed only using the specified system. Intermediate and finish coats shall be field applied. The manufacturer of all pumps, motors, and similar mechanical equipment shall submit a written certification to the ENGINEER that the surface preparation and prime coats satisfy the specification

requirements. This certification shall be submitted and accepted prior to release for shipment. Touch up shall be applied as required. The equipment manufacturer shall submit written documentation confirming the surface preparation and coating is per specification. The CONTRACTOR is specifically advised that the dry film thickness of all factory applied coatings will be field confirmed by the ENGINEER. Any coating not meeting the requirements of the specifications, in the sole opinion of the ENGINEER, shall be removed, surface preparation repeated and the coating re-applied in the field to the satisfaction of the ENGINEER.

3. All existing ferrous surfaces to be recoated shall be high pressure washed to achieve complete removal of all stains, dirt, grime, mold, mildew, etc. The pressure shall be as required to achieve the desired result without damage to the existing coating. Subsequently, any areas with remaining contamination with oils or greases shall be solvent cleaned. Rust shall be removed by hand-tool cleaning and existing coatings scarified, if recommended by the coating manufacturer for proper adhesion. Particular care shall be taken during the surface preparation to protect the functional integrity of all mechanical equipment during the surface preparation procedure. Non-coated items such as nameplates, rotating shafts, non-painted valves and couplings shall be masked or otherwise protected during the surface preparation and coating operations.
4. Except as noted in item 2 above, all surface preparation and coating work shall be performed in the field, unless otherwise specifically identified in the specification or on the drawings.

F. Cementitious Materials:

1. Prepare cementitious surfaces of concrete, concrete block, to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. Concrete surfaces, other than concrete block, shall be brush blasted per SSPC SP-13 to open bug holes.
2. Determine the alkalinity and moisture content of the surfaces to be painted by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish paint, correct this condition before application of paint. Do not paint over surfaces where the moisture content exceeds that permitted in the manufacturer's printed directions. The CONTRACTOR shall provide written documentation to the ENGINEER that the alkalinity and moisture content of any cementitious surface is acceptable and within the coating manufacturer's recommended limits for application of the coating.
3. All existing cementitious surfaces to be recoated shall be pressure washed to completely remove all stains, chemicals, dust, grime, mold, mildew, etc. The pressure shall be as required to achieve the desired result without damage to the existing coating. Solvent cleaning shall be used to remove any oils or greases remaining after the pressure washing. Pressure washing and water blasting shall be performed in a fashion that does not cause physical damage to the substrate. Care shall be taken to not damage caulking attachments, openings, fascia, architectural items, screens, etc. during the surface preparation procedures. The application of the coating to existing facilities shall occur as soon after the completion of surface preparation as practical,

before re-contamination of the substrate and in no case more than 45 days after completion of the surface preparation.

4. Repair all cracks to the satisfaction of the ENGINEER on cementitious structures prior to the application of coating systems. Repair of cracks shall be considered to include restoration of surface profile to a condition consistent with adjacent similar structures where the surface preparation work has inadvertently or intentionally caused damage.
5. Unless otherwise noted, all surface preparation and coating work shall be performed in the field.

G. PVC, FRP, PE, Aluminum, Stainless Steel, Copper Surfaces, Not Previously Painted:

1. Clean free of oil and surface contaminants with an acceptable non-petroleum based solvent. All surfaces shall be prepared according to SSPC SP-2 Hand Tool Cleaning or SSPC-SP3 Power Tool Cleaning, to scarify prior to applying coatings.

3.3 PROTECTION OF PROPERTY AND STRUCTURES

- A. Protect property and structures adjacent to the Work from waste residues resulting from cleaning, surface preparation, and painting Work.
- B. Use shrouding, vacuum blasting, or other acceptable methods for cleaning and surface preparation of exterior surfaces.
- C. During blast cleaning and surface preparation of interior and exterior surfaces, control exhausting of dust and grit using shrouding, negative-pressure containment/dust collection systems, or other means to protect adjacent property and structures and prevent dust and grit from escaping. Similarly, control removal and temporarily store residues to protect adjacent property and structures.
- D. For painting of exterior surfaces, use rollers, shrouding, or other acceptable methods as required to protect adjacent property and structures from wind-blown paint residues.
- E. Submit proposed procedures for cleaning, surface preparation, and paint application that describe in detail methods to be used to protect adjacent property and structures from residues. Do not proceed with cleaning, surface preparation, or painting until proposed procedures are accepted by ENGINEER.

3.4 MATERIALS PREPARATION

- A. General: Mix and prepare painting products in strict accordance with paint manufacturer's product data sheets.

3.5 APPLICATION

- A. General:
 1. Apply paint systems by brush, roller, or airless spray per paint manufacturer's recommendations and in compliance with Paint

- Application Specifications No. 1 in SSPC Volume 2, where applicable, and in strict accordance with paint manufacturer's product data sheets.
2. Surfaces of items not normally exposed-to-view require same painting system specified for exposed surfaces of system.
 3. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint before final installation of registers or grilles.
 4. Paint backs of access panels and removable or hinged covers to match exposed surfaces.
 5. Omit field-applied primer on metal surfaces that have been primed in the shop. Touch-up paint to shop-primed coats and pre-finished items only when approved by ENGINEER using compatible primers and paint manufacturer's recommended compatible field-applied finishes.
 6. Welds shall be stripe-coated with intermediate or finish coat of paint after application of prime coat.
- B. Minimum/Maximum Paint Film Thickness:
1. Comply with manufacturer's published recommendations for coating type and surface.
- C. Scheduling Surface Preparation and Painting: Comply with manufacturer's published recommendations for coating type and surface.
- D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to result in a finish coat with no burn-through or other defects caused by insufficient sealing.
- E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.
- F. Brush Application:
1. Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable. Neatly draw all glass and color break lines.
 2. Brush-apply all primer or first coats, unless otherwise allowed to use mechanical applicators.
- G. Mechanical Applicators:
1. Use mechanical methods for applying paint when allowed by applicable ordinances, paint manufacturer, and approved by ENGINEER.
 2. Limit roller applications, if approved by ENGINEER, to interior wall finishes for second and third coats. Apply each roller coat to provide equivalent hiding as brush-applied coats.
 3. Where spray application is used, apply each coat to provide equivalent hiding of brush-applied coats. Do not double back with spray equipment for purpose of building up film thickness of two coats in one pass.
- H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by ENGINEER.

3.6 FIELD QUALITY CONTROL

- A. Notify ENGINEER after completing each coat of paint. After inspection and checking of film thickness, holidays, and imperfections, and after acceptance by ENGINEER, proceed with succeeding coat. Perform testing using approved testing instruments.
 - 1. ENGINEER will witness all testing and shall be notified of scheduled testing at least twenty-four hours in advance.
 - 2. Apply additional coats, if required, to produce specified film thickness and to correct holidays and to completely fill all surface air holes.
- B. For magnetic substrates, measure thickness of dry film nonmagnetic coatings following recommendations of SSPC PA-2. These procedures supplement manufacturers' approved instructions for manual operation of measurement gauges and do not replace such instructions.
- C. Record time, location, number of coats, dry film thickness, holidays, and other imperfections and submit testing results to ENGINEER.

3.7 PROTECTION

- A. Provide "Wet Paint" signs as required to protect newly painted finishes. After completing painting Work, remove temporary protective wrappings provided for protection of the Work and work of other contractors.

3.8 ADJUSTMENT AND CLEAN-UP

- A. Correct damage to work of other trades by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.
- B. During progress of the Work, remove from Site all discarded paint products, rubbish, cans, and rags at end of each workday.
- C. Upon completion of painting, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.
- D. At completion of Work of other trades, touch-up and restore all damaged or defaced painted surfaces as determined by ENGINEER.

+ + END OF SECTION + +

SECTION 26 05 05

GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to complete the electrical Work.
2. Temporary Utilities: CONTRACTOR shall provide temporary power and lighting in accordance with Section 01 51 05, Temporary Utilities.
3. Demolition: Responsibility for electrical demolition is indicated in Section 01 11 13, Summary of Work.
4. Utility Companies:
 - a. Electric Utility Company: Perform the Work in connection with the electric service and utility metering in accordance with requirements of FP&L.

B. Coordination:

1. Review installation procedures and schedules under other Specification Sections and coordinate with other trades the installation of electrical items that will be installed with or within formwork, walls, partitions, ceilings, and panels.
2. Coordination and Intent of Electrical Drawings:
 - a. Dimensions on Drawings related to equipment are based on equipment of certain manufacturers. Verify the dimensions of equipment furnished to space available at the Site and allocated to the equipment.
 - b. Drawings show the principal elements of the electrical Work, and are not intended as detailed working drawings for the electrical Work. Drawings supplement and complement the Specifications and other Contract Documents relative to principal features of electrical systems.
 - c. Equipment and devices provided under this Contract shall be properly connected and interconnected with other equipment and devices for successful operation of complete systems, whether or not all connections and interconnections are specifically mentioned or shown in the Contract Documents.
 - d. Drawings are provided for CONTRACTOR's guidance in fulfilling the intent of the Contract Documents CONTRACTOR shall comply with Laws and Regulations, including safety and electrical codes, and provide materials, equipment, appurtenances, and specialty items necessary for complete and operable systems.
3. Obtain from OWNER record drawings required to execute the Work.
4. Field Coordination:
 - a. Provide materials, equipment, and services to interface with existing circuits. Field-verify system and equipment requirements prior to modifying existing systems.
 - b. Coordinate the interface of equipment with OWNER's personnel and field conditions.

- c. Field-compare existing starter and panel control circuit terminations from record documents with existing circuits.
 - d. Field-trace existing circuits as required to interface the equipment provided.
 - e. Field-identify terminations for starters and panel controls for follow function for re-connection.
- C. Related Sections:
 - 1. Section 02 41 00, Demolition.
 - 2. Section 03 00 05, Concrete.
 - 3. Section 05 05 33, Anchor Systems.
 - 4. Section 09 91 00, Painting.
 - 5. Section 31 23 05, Excavation and Fill.
 - 6. Section 40 60 00, Common Work Results for Process Control and Instrumentation Systems.
- D. Materials and Equipment Installed by CONTRACTOR but Furnished by Others:
 - 1. Odor Control System
- E. Area Classifications:
 - 1. Materials, equipment, and incidentals shall be suitable for the area classification(s) shown, specified, and required.
 - 2. Wet Locations: Comply with NEC and NEMA requirements for wet locations. Enclosures in wet locations shall comply with NEMA 4X unless specified otherwise.
 - 3. Corrosive Locations: Comply with NEC and NEMA requirements for corrosive locations. Enclosures in corrosive locations shall conform to NEMA 4X requirements unless specified otherwise.
 - 4. Hazardous Locations: Comply with NEC requirements for the Class and Division designated.
 - 5. Dusty Locations: Indoor areas not designated as hazardous, corrosive, or wet are dusty locations. Comply with NEC and NEMA 12 requirements unless specified otherwise.

1.2 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Electrical Subcontractor:
 - a. Electrical Subcontractor shall possess a valid electricians' and contractors' license in the jurisdiction where the Site is located.
 - 2. Wiring Coordinator:
 - a. Retain services of a wiring coordinator who shall prepare complete point-to-point interconnection wiring diagrams. Diagrams shall identify all external interconnecting wiring associated with new or modified existing equipment.
 - b. Responsibilities:
 - 1) Develop diagrams for performing the Work and to document terminations. Prepare diagrams in accordance with this Section and the example wiring diagram accepted by ENGINEER. Diagrams are in addition to loop diagrams required in Section 40 60 00, Common Work Results for Process Control and Instrumentation System.

- 2) Use information obtained from approved Shop Drawings and approved CONTRACTOR's other submittals, record drawings, and field inspections as required to complete the diagrams.
 - 3) Attend pre-submittal conference required under Section 40 60 00, Common Work Results for Process Control and Instrumentation System, and periodic coordination and progress meetings required in Section 01 31 13, Project Coordination; Section 01 31 20, Progress Meetings; and Section 40 60 00, Common Work Results for Process Control and Instrumentation System.
- B. Component Supply and Compatibility:
1. Materials and equipment similar to each other shall be from the same manufacturer for uniformity.
- C. Regulatory Requirements:
1. Permits: Refer to the General Conditions and other parts of the Contract Documents for responsibilities relative to obtaining and paying for permits, licenses, and inspection fees.

1.3 SUBMITTALS

- A. General:
1. To the extent practical, submit Shop Drawings and other CONTRACTOR submittals for each Specification Section into the smallest number of submittals possible. Do not furnish partial submittals.
 2. Review of equipment submittals does not relieve CONTRACTOR of responsibility for providing complete and successfully operating systems.
- B. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
 - b. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
 - c. List of components including manufacturer's name and catalog number (or part number) for each.
 - d. Point-to point interconnection wiring diagrams.
 2. Product Data:
 - a. Manufacturer's name and product designation or catalog number.
 - b. Electrical ratings.
 - c. Manufacturer's technical data and specifications.
 - d. Manufacturer's indication of compliance with applicable reference standards.
 - e. Painting and coating systems proposed.
 3. Test Procedures: Proposed testing procedures and testing limitations for source quality control testing and field quality control testing.
- C. Informational Submittals: Submit the following:
1. Manufacturer's Instructions:
 - a. Installation data and instructions.
 - b. Instructions for handling, starting-up, and troubleshooting.
 2. Source Quality Control Submittals: Results for required shop testing.
 3. Field Quality Control Submittals: Results for required field testing.

- D. Closeout Submittals: Submit the following:
1. Record Documentation:
 - a. System Record Drawings: Include the following:
 - 1) One-line wiring diagram of the electrical distribution system.
 - 2) Actual, in-place conduit and cable layouts with schedule of conduit sizes and number, and size of conductors.
 - 3) Layouts of the power and lighting arrangements and the grounding system.
 - 4) Control schematic diagrams, with terminal numbers and control devices identified, for all equipment.
 - b. Point-to-Point Interconnection Wiring Diagram Drawings: Include the following:
 - 1) External wiring for each piece of equipment, panel, instrument, and other devices and wiring to control stations, lighting panels, and motor controllers.
 - 2) Numbered terminal block identification for each wire termination.
 - 3) Identification of the assigned wire numbers for all interconnections.
 - 4) Identification of wiring by the conduit tag in which the wire is installed.
 - 5) Terminal, junction, and pull boxes through which wiring is routed.
 - 6) Identification of equipment and the submittal transmittal number for equipment from which wiring requirements and termination information was obtained.
 - c. Record documents shall indicate final equipment and field installation information.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Accordance with Section 01 65 00, Product Delivery Requirements and Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

- A. Performance Criteria:
1. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, with ambient outside air temperature of 25 degrees F to 105 degrees F and an elevation of 30 feet above mean sea level.
 2. Unless specified otherwise, electrical equipment shall have ratings based on 75 degrees C terminations.
- B. Testing Laboratory Labels: Electrical material and equipment shall bear the label of Underwriters' Laboratories, Inc. or other nationally recognized, independent testing laboratory, where standards have been established and label service applies.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work will be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:
 - 1. Install materials and equipment in accordance with the Contract Documents, Laws and Regulations, approved (and accepted, as applicable) Shop Drawings and other CONTRACTOR submittals, and manufacturer's recommendations.
 - 2. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.
 - 3. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure proper interface of components. The Contract Price includes all costs associated with field services specified for a complete and functional system.
- B. Staging, Sequencing, and Coordination with Existing Facilities:
 - 1. Schedule, sequence, and install materials and equipment.
 - 2. Perform the Work in a manner that will not interfere with the existing equipment and facilities or cause interruption of the functions of the Site, unless specified otherwise or otherwise allowed by OWNER.
 - 3. When operation of existing facilities and Site is disrupted due to CONTRACTOR's operations, unless otherwise allowed by OWNER.
 - 4. Where the Work ties in with existing installations, take precautions and provide safeguards in connecting the Work to existing operating circuits to prevent interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of OWNER and ENGINEER.
 - 5. Interruptions of existing circuits shall be coordinated with the OWNER who will determine the length of time a circuit may be de-energized to maintain the OWNER's processes in dependable and safe operation.

3.3 FIELD QUALITY CONTROL

- A. Field Quality Control – General:
 - 1. Perform field quality control for electrical Work in accordance with the Contract Documents.
- B. Site Tests:
 - 1. Prior to requesting certificate of Substantial Completion, demonstrate to ENGINEER that electrical systems and electrically-operated equipment installed or modified under the Contract operates in accordance with the Contract Documents and operates as required
 - 2. Perform the following operational tests on electrical systems:
 - a. Operate power circuits to verify proper operation and connection to electrical systems materials and equipment, including mechanical key-interlocks for circuit breakers (if applied).
 - b. Operate control circuits, including pushbuttons, indicating lights, and similar devices, to verify proper connection and function. Operate all devices, such as pressure switches, flow switches, and similar devices, to verify that shutdowns and control sequences operate as required.
 - c. Operate lighting systems and receptacle devices to verify proper operation and connections.

3. Prepare and submit report on the equipment demonstration and operating field quality control tests. Report shall include complete information on the tests performed and results.
- C. Manufacturer's Services:
1. Furnish at the Site qualified, factory-trained representative(s) of equipment manufacturers for the services indicated in the Contract Documents.

+ + END OF SECTION + +

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling.
 - 2. Types of cabling required include:
 - a. Insulated cable for installation in raceways.
- B. Related Sections:
 - 1. Section 26 05 53, Identification for Electrical Systems.
 - 2. Section 31 23 05, Excavation and Fill.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - 2. ASTM B3, Specification for Soft or Annealed Copper Wire.
 - 3. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
 - 4. ASTM D3485, Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable.
 - 5. ASTM F2160, Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
 - 6. NEMA TC 7, Smooth Wall Coilable Electrical Polyethylene Conduit.
 - 7. UL 44, Thermoset-Insulated Wires and Cables.
 - 8. UL 1277, Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 300, Wiring Methods.
 - 2. NEC Article 310, Conductors for General Wiring.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's literature, specifications, and engineering data for low volt insulated cable proposed for use.
- B. Informational Submittals: Submit the following:
 - 1. Field Quality Control Submittals:
 - a. Written results of field insulation resistance tests.

PART 2 – PRODUCTS

Home Depot MPS and FM
Low-Voltage Electrical Power
Conductors and Cables
30036073

2.1 MATERIALS

- A. Insulated Cable In Raceways:
 - 1. Application: Use for circuits located indoors and outdoors in conduits, ducts, troughs and trays. Cable shall be suitable for use in Class I, Division 2 hazardous locations per NEC Article 501.
 - 2. Manufacturers: Provide products of one of the following:
 - a. Southwire.
 - b. The Okonite Company.
 - c. American Insulated Wire
 - d. General Cable
 - e. Or equal.
 - 3. Material: Single conductor copper cable complying with ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW-2 or RHW-2 complying with UL 44.
 - 4. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
 - 5. Stranding: 600-volt cable shall be stranded, except that solid cable, No. 10 and smaller may be used for lighting circuits.
- B. Fire-Rated Cable: (Not Used)
- C. Cable for Installation in Trays: (Not Used)
- D. Direct-Burial Cable: (Not Used)
- E. Direct-Burial Cable Duct: (Not Used)
- F. Cable Connectors, Solderless Type:
 - 1. Products and Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Hylug.
 - c. Or equal.
 - 2. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
 - 3. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
 - 4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
 - 5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90 degree C, 600 volts.
- G. Cable Splices:
 - 1. Products and Manufacturers:
 - a. Compression-Type Splices: Provide one of the following:
 - 1) Burndy Hylink.
 - 2) T&B Color-Keyed Compression Connectors.
 - 3) Or equal.

- b. Spring Connectors: Provide one of the following:
 - 1) Buchanan B-Cap.
 - 2) T&B Wire Connector.
 - 3) Or equal.
 - 2. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by cable manufacturer to provide insulation equal to that on conductors.
 - 3. For wire sizes No. 10 AWG and smaller, splices may be made up with pre-insulated spring connectors.
 - 4. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
 - 5. Splices shall be suitably sized for cable, rated 90 degrees C, and 600 volts.
- H. Wire and Cable Markers:
- 1. Provide wire and cable markers in accordance with Section 26 05 53, Identification for Electrical Systems.

2.2 SOURCE QUALITY CONTROL

- A. Factory Tests:
- 1. Factory-test wire and cable in accordance with UL standards

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.
- B. Pulling:
- 1. Use insulating types of pulling compounds containing no mineral oil.
 - 2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
 - 3. Use dynamometer where mechanical means are used.
 - 4. Cut off section subject to mechanical means.
- C. Bending Radius: Limit to minimum of six times cable overall diameter.
- D. Slack: Provide maximum slack at all terminal points.
- E. Splices:
- 1. Where possible, install cable continuous, without splice, from termination to termination.
 - 2. Where required, splice as shown and also where required for cable installation. Splices below grade, in manholes, handholes, and wet locations shall be waterproof.
 - 3. Splices are not allowed in conduits.

F. Identification:

1. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
2. Identify power conductors by circuit number and phase at each terminal or splice location.
3. Identify control and status wiring using numeral tagging system.

G. Color-code power cables as follows:

1. No. 8 AWG and Smaller: Provide colored conductors.
2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.
3. Colors: Match color scheme in use at the Site. If the Site does not have an existing color scheme, use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow

3.2 FIELD QUALITY CONTROL

A. Site Tests:

1. Test each electrical circuit after permanent cables are in place, to demonstrate that circuit and equipment are connected properly and will perform satisfactorily, free from improper grounds and short circuits.
2. Individually test 600-volt cable mechanical connections after installation and before they are put in service, with calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.
3. Individually test 600-volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service, with Megger for one minute at voltage rating recommended by cable manufacturer or in accordance with ANSI/NETA ATS recommendations.
4. Insulation resistance for each conductor shall not be less than value recommended by cable manufacturer. Cables not meeting recommended value or that fail when tested under full load conditions shall be replaced with a new cable for full length.

5. Where existing cables are spliced to cables provided under the Project, test existing cables prior to splicing. Test cables at 1,000 vdc for one minute. Entire spliced cable installation shall be re-tested after splice is completed. Existing cable that fails or has value less than two megohms shall be brought to attention of ENGINEER and splicing shall not proceed until condition is acceptable.

+ + END OF SECTION + +

SECTION 26 05 23

INSTRUMENTATION AND COMMUNICATION CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.
 - 2. Types of cables include the following:
 - a. Shielded instrumentation cables.
 - b. Data communication cables.
- B. Related Sections:
 - 1. Section 26 05 33.13, Rigid Conduits.
 - 2. Section 26 05 53, Identification for Electrical Systems.

1.2 TERMINOLOGY

- A. The following words or terms are not defined but, when used in this Section, have the following meaning:
 - 1. "CPE" means chlorinated polyethylene.
 - 2. "FEP" means fluorinated ethylene-propylene.
 - 3. "XLPE" means cross-linked polyethylene.

1.3 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ASTM A510, Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - 2. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - 3. ANSI/TIA/EIA-568, Commercial Building Telecommunications Cabling (requirements and restrictions of Technical Service Bulletins (TSBs) apply.)
 - 4. TIA/EIA-485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems (known as RS-485).
 - 5. UL 13, Power-Limited Circuit Cables.
 - 6. UL 1581, Electrical Wires, Cables and Flexible Cords.
 - 7. UL VW-1, Vertical Wire Flame Test.
 - 8. UL 910, Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NEC 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
 - 2. NEC 727, Instrumentation Tray Cable.
 - 3. NEC 800, Communications Circuits.

1.5 SUBMITTALS

Home Depot MPS and FM

Instrumentation and Communication Cable

30036073

26 05 23-1

- A. Action Submittals: Submit the following:
 - 1. Product Data: Manufacturer's technical information for instrumentation cables and communications cables proposed.
- B. Informational Submittals: Submit the following:
 - 1. Field Quality Control Submittals: Written report of results of field quality control testing specified in this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. General:
 - 1. Cables shall bear the UL label.
- B. Single Shielded Pair Instrument Cables:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 - 2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581.
- C. Multi-Paired Shielded Instrument Cables:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 - 2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, twisted pairs with shield over each pair, stranded tinned no. 18 AWG copper drain wire, and overall PVC or CPE outer jacket. Rated for not less than 600 volts and complying with either UL 1581 or UL 13.
- D. Multi-Conductor Shielded Instrument Cables:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 - 2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, stranded tinned no. 18 AWG copper drain wire, with overall 100 percent foil shield and overall PVC or CPE jacket. Rated for not less than 600 volts.
- E. Multi-Conductor Shielded High-Temperature Instrument Cables: (Not Used)
- F. Multi-Conductor Shielded Plenum-Rated Instrument Cables: (Not Used)
- G. Multi-Conductor Telephone Cables: (Not Used)

- H. Cable Terminals:
 - 1. Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Insulug.
 - c. Or equal.
 - 2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.
- I. Horizontal Unshielded Twisted Pair (UTP) Cables:
 - 1. Horizontal cabling is cabling between and including the telecommunications outlet/connector and patch panel or termination block.
 - 2. Manufacturers: Provide products of one of the following:
 - a. Bertek.
 - b. Belden.
 - c. Mohawk
 - d. Or equal.
 - 3. Cables shall consist of no. 24 AWG, thermoplastic-insulated, solid conductors formed into four individually-twisted pairs and enclosed by thermoplastic jacket.
 - 4. Comply with ANSI/TIA/EIA-568, Part 10.2.
 - 5. Riser-rated where installed in conduit. Other installations shall be plenum-rated.
 - 6. Rated for Category 6 use.
- J. Patch Cords: (Not Used)
- K. Connecting Hardware for Unshielded Twisted Pair (UTP) Cables:
 - 1. Hardware used to terminate UTP cable shall comply with ANSI/TIA/EIA-568, Part 10.4.
 - 2. Connecting hardware shall be compatible with wiring specified in the Contract Documents.
 - 3. Rated for Category 6 use.
 - 4. Connecting hardware shall utilize 110-type terminal blocks to coordinate with patch panels and termination blocks specified the Contract Documents.
 - 5. Telecommunications Outlets/Connectors:
 - a. Manufacturers: Provide products of one of the following:
 - 1) Hubbell.
 - 2) Or equal.
 - b. Outlets and connectors shall utilize RJ45 (eight-pin modular) plug/receptacle configuration.
 - c. Outlets and connectors shall utilize T568B pin/pair assignments, and be coordinated with wire type (solid or stranded conductor).
 - d. Outlets shall be flush-mount type or surface-mount type, as indicated on the Drawings.
- L. Patch Panels: (Not Used)
- M. Cable Support Hardware:
 - 1. Wire Basket: (Not Used)
 - 2. Conduit:

- a. Where conduit is shown or indicated on the Drawings, comply with Section 26 05 33.13, Rigid Conduits.

- N. Modbus Cables (RS-232): (Not Used)
- O. Modbus-Plus Cables: (Not Used)
- P. Modbus RIO Cables: (Not Used)
- Q. Fieldbus Type A Cables: (Not Used)
- R. Fieldbus Type B Cables: (Not Used)
- S. Cutler-Hammer IMPACC Cables: (Not Used)
- T. Cutler-Hammer I/Q System Cables: (Not Used)
- U. Rotork Pakscan IIE Cables: (Not Used)
- V. Limitorque Actuator Bus Cables: (Not Used)
- W. Allen Bradley DH (Blue Hose) Cables: (Not Used)
- X. ControlNet Cables: (Not Used)
- Y. Devicenet (Thick) Cables: (Not Used)
- Z. Devicenet (Thin) Cables: (Not Used)
- AA. Profibus DP Cables: (Not Used)
- BB. Profibus PA Cables: (Not Used)
- CC. RS-485 Half Duplex Cables: (Not Used)
- DD. RS-485 Full Duplex Cables: (Not Used)

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:
 - 1. Install cables complete with proper terminations at both ends.
 - 2. Install in conduit separate from power cables, unless shown or indicated otherwise.

3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
4. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
5. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.
6. Install in accordance with Laws and Regulations, including NEC.

3.3 FIELD QUALITY CONTROL

A. Site Tests:

1. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.
2. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.
3. Replace with new cables the full length of cables that fail test.
4. Test equipment shall be provided by CONTRACTOR.
5. For testing of communications cables, test equipment used shall comply with the following:
 - a. Equipment shall consist of a "master" and a "remote" unit.
 - b. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of accepting cable identification tag for reporting. Test unit shall return "pass/fail" status for cables and, if "fail", shall indicate reason for failure.
 - c. Test unit shall be capable of storing all test results internally and printing the results later.
 - d. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category 6 compliant.

+ + END OF SECTION + +

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical systems, structures, and equipment.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
2. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
3. UL 467, Grounding and Bonding Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Field Acceptance Testing Firm: Retain services of independent testing firm to perform acceptance field testing of grounding system. Testing firm shall have experience in testing grounding systems and shall be a member company of NETA.

B. Regulatory Requirements

1. National Electrical Code, (NEC).
 - a. NEC Article 250, Grounding and Bonding.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Listing of grounding connector types identifying where each will be used.
 - b. Layouts of each structure's ground grid.
 - c. Test point construction details.
2. Product Data:
 - a. Manufacturer's technical information for grounding materials proposed for use.
3. Testing Plans:
 - a. Ground resistance test procedure.

B. Informational Submittals: Submit the following:

1. Field Quality Control Submittals
 - a. Results of ground resistance tests at each test point.

PART 2 – PRODUCTS

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2.1 MATERIALS

- A. Bare Ground Cable:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Cablec Corporation.
 - b. General Cable Corporation.
 - c. Southwire Cable Company.
 - d. Or equal.
 - 2. Material: Soft-drawn, bare copper stranded cable complying with ASTM B8. No. 4/0 AWG minimum size unless otherwise shown or indicated on the Drawings.
- B. Ground Rods:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Copperweld, Bimetallics Division.
 - b. ITT Blackburn Company.
 - c. Or equal.
 - 2. Material: Copper-clad rigid steel rods, 3/4-inch diameter, ten feet long.
- C. Grounding Connectors:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Pressure Connectors:
 - 1) O.Z./Gedney, Division of General Signal Corporation.
 - 2) Burndy Corporation.
 - 3) Or equal.
 - b. Welded Connections:
 - 1) Cadweld by Erico Products, Incorporated.
 - 2) Therm-O-Weld by Burndy Corporation.
 - 3) Or equal.
 - 2. Material: Pressure connectors shall be copper alloy castings, designed and fabricated specifically for items to be connected and assembled with Durium or silicone bronze bolts, nuts, and washers. Welded connections shall be by exothermic process utilizing molds, cartridges, and hardware designed specifically for connection to be made.
- D. Grounding Additive: (Not Used)
- E. Ground Test Well
 - 1. Provide asper indicated in the drawings.
- F. Ground system components shall comply with UL 467.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions for the Work and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 STRUCTURE GROUND SYSTEM

- A. Provide ground grids as shown and indicated on the Drawings.

- B. Provide No. 4/0 bare copper cable around exterior perimeter of structures at not less than 2.5 feet below grade, unless otherwise shown or indicated on the Contract Documents.
- C. For structures with steel columns, provide No. 4/0 ground cable from grid to each column around perimeter of structure. Connect cable to steel with exothermic welds.
- D. Connect grids to continuous underground water pipe system, when practical.
- E. For new structures with concrete foundation or footings, connect structure's reinforcing steel or other concrete-encased electrode to grounding grid.
- F. Provide accessible test points for measuring the ground resistance of each grid.
- G. Weld all buried connections except for test points.

3.3 EQUIPMENT GROUNDING

- A. Ground electrical equipment in compliance with Laws and Regulations and the Contract Documents.
- B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where required for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors, shall be insulated. Insulation shall be green.
- C. Control panels grounding conductors shall be bare stranded copper cable of adequate size to ground grid from AC ground bus, and an insulated stranded copper cable of adequate size to ground grid from DC ground bus.
- D. Connect ground conductors to conduit with copper clamps, straps, or with grounding bushings.
- E. Connect to piping by welding or brazing. Use copper bonding jumpers on gasketed joints.
- F. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use hold-down bolts. Where grounding provisions are not included, drill suitable holes in locations recommended by equipment manufacturer or designated by ENGINEER.
- G. Connect to motors by bolting directly to motor frames, not to soleplates or supporting structures.
- H. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on gasketed joints.
- I. Scrape bolted surfaces clean and coat with conductive oxide-resistant compound.

3.4 FIELD QUALITY CONTROL

A. Site Tests:

1. Test completed grounding systems for resistance to ground using an electrical three-terminal ground resistance tester. Test all grounded cables and metal parts for continuity of connection. ENGINEER and OWNER will witness the testing.
2. Grounding system maximum resistance shall not exceed five ohms under normally dry conditions when measured by resistance tester. Resistance values above five ohms shall be brought to ENGINEER's attention. Provide additional ground rods as required to attain a resistance to ground of less than five ohms for each ground grid. Add grounding additive installing additional ground rods to increase their effectiveness.
3. Acceptance Testing:
 - a. Perform acceptance testing of grounding system. Testing shall be performed by testing firm in accordance with ANSI/NETA ATS.
 - b. Test Equipment, Calibration and Reporting: Test equipment, instrument calibration, and test reports shall comply with ANSI/NETA ATS.

+ + END OF SECTION + +

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install hangers and supports for electrical systems.
2. Area Classifications: Materials shall be suitable for the area classification(s) shown or indicated on the Drawings, and specified in Section 26 05 05, General Provisions for Electrical Systems.

B. Related Sections:

1. Section 05 05 33, Anchor Systems.
2. Section 26 05 05, General Provisions for Electrical Systems.
3. Section 26 05 33.13, Rigid Conduits.

1.2 REFERENCES

A. Standards referenced in this section are:

1. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
3. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Detailed installation drawings showing dimensions and compatibility with proposed layout.
2. Product Data:
 - a. Manufacturer's name, product designation, and catalog number of each material item proposed for use.
 - b. Manufacturer's specifications including material, dimensional and weight data, and load capacity for each supporting system component proposed for use.
 - c. Pictorial views and corresponding identifying text of each component proposed for installation.
 - d. Documentation that confirms product compatibility with Laws and Regulations.

B. Informational Submittals: Submit the following:

1. Certifications:
 - a. Submit certifications required under this Section.
2. Manufacturer's Instructions:

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- a. Manufacturer's installation instructions, including recommended tightening torque values for all nuts and bolts.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 1. B-Line.
 2. Kindorf.
 3. Unistrut
 4. Or equal.

2.2 MATERIALS

- A. Strut, Fittings, and Accessories:
 1. General
 - a. Unless otherwise shown or indicated, strut shall be 1-5/8 inches by 1-5/8 inches. Double struts shall be two pieces of the same strut, welded back-to-back at the factory.
 - b. Attachment holes, when required, shall be factory-punched on hole centers approximately equal to the cross-sectional width and shall be 9/16-inch diameter.
 - c. Fittings, braces, brackets, hardware, and accessories shall be Type 316 stainless steel.
 - d. Strut nuts shall be spring captured Type 316 stainless steel.
 - e. Square and round washers shall be Type 316 stainless steel.
 2. Strut materials shall be suitable for area classifications indicated in Section 26 05 05, General Provisions for Electrical Systems, and shown or indicated on the Drawings.
 - a. Dusty Locations:
 - 1) Strut shall be 12-gage carbon steel, complying with ASTM A1011/A1011M, painted with an electroplated epoxy base paint.
 - b. Wet Locations:
 - 1) Strut shall be 12-gage Type 316 stainless steel.
 - c. Corrosive Locations:
 - 1) Strut shall be 12-gage Type 316 stainless steel.
- B. Hanger Rods:
 1. Material:
 - a. Dry Locations: All-thread, zinc-coated
 - b. Wet, Corrosive, or Hazardous Areas: Stainless steel.
 2. Size: Not less than 3/8-inch diameter, unless otherwise shown on the Drawings or specified.
- C. Beam Clamps for Attaching Threaded Rods or Bolts to Beam Flanges for Hanging Struts or Conduit Hangers:
 1. Beam clamps shall be stainless steel equipped with stainless steel square-head set screw, and shall include threaded hole sized for attaching the all-thread rod or threaded bolt.
- D. Miscellaneous Hardware:
 1. Bolts, screws, and washers shall be 316 stainless steel.

2. Hex Nuts: Shall be 316 stainless steel and include nylon inserts.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Provide hangers and supports for electrical systems with necessary channels, fittings, brackets, and related hardware for mounting and supporting materials and equipment. Provide anchor systems, concrete inserts, and associated hardware for proper support of electrical systems.
- B. Install equipment and devices on hangers and supports as shown on the Drawings, as specified, and as required.
- C. Install hangers and supports level, true, free of rack, and parallel and perpendicular to building walls and floors, so that the hangers and supports are installed in a neat, professional, workmanlike manner.
- D. Holes in suspended ceilings for rods for hangers and supports and other equipment shall be provided adjacent to bars, where possible, to facilitate removal of ceiling panels.
- E. Coordinate installation of hangers and supports with equipment, cabinets, consoles, panels, enclosures, boxes, conduit, cable tray, wireway, busway, cablebus, piping, ductwork, lighting fixtures, and other systems and equipment. Locate hangers and supports clear of interferences and access ways.
- F. Anchor Bolts, Expansion Anchors, and Concrete Inserts: Shall be in accordance with Section 05 05 33, Anchor Systems, and requirements of this Section.
- G. Mounting of Conduit:
 1. Provide space of not less than 1/4-inch between conduit surfaces and abutting or near surfaces except struts, cable trays, steel beams, and columns.
 2. Fasten conduit to struts, cable trays, steel beams, and columns using specified clamps and straps as shown, specified, and required.
 3. Devices shall be compatible with size of conduit and type of support. Following installation, size identification shall be visible and legible.
 4. Install conduit supports and fasteners in accordance with Section, 26 05 33.13, Rigid Conduits.
- H. Supports for Cabinets, Consoles, Panels, Enclosures, and Boxes:
 1. Freestanding: Unless otherwise specified or shown on the Drawings, provide supports for floor-mounted equipment, cabinets, consoles,

panels, enclosures, and boxes. Such supports shall be 3.5-inch high concrete equipment base with a 45 degree chamfered edge. Base shall extend two inches beyond outside dimensions of equipment on all sides.

2. Wall-Mounted:
 - a. Provide space not less than 1/4-inch between cabinets, consoles, panels, enclosures, and boxes and the surface on which each is mounted. Provide non-metallic or stainless steel spacers as required.
 - b. Do not mount equipment, enclosures, panels, and boxes directly to beams or columns. Mount struts to beams or columns using beam clamps, and mount equipment, enclosures, panels, and boxes to the struts.
3. Floor Stand Rack:
 - a. Where equipment, cabinets, consoles, panels, enclosures, and boxes cannot be wall-mounted, provide an independent floor stand rack.
 - b. Floor stand rack shall consist of struts, plates, brackets, connection fittings, braces, accessories, and hardware assembled in a rigid framework suitable for mounting of intended materials and equipment.
 - c. Equip floor stand racks with brackets and bases for rigidly-mounting the framework to the ceiling or floor, as applicable; or equip floor stand racks with beam clamps, angle plates, washers, and bolts for fastening to beam flanges, as applicable.
 - d. When equipment, cabinets, consoles, panels, enclosures, and boxes weigh more than 100 pounds:
 - 1) Main vertical supports of floor stand rack assemblies shall be back-to-back struts.
 - 2) Bracing, clamping and anchoring of each floor stand rack shall be sufficient to ensure rigidity of the floor stand rack with the intended equipment, enclosures, conduit, cable tray, busway, cablebus, and wireway installed. Floor stand racks shall not be deflected more than 1/8-inch by a 100-pound force applied at any point on the floor stand rack in any direction.

I. Drilling into beams or columns is not allowed unless authorized by ENGINEER.

J. Tighten nuts and bolts to the manufacturer's recommended torque values.

K. Field Cutting:

1. Cut edges of strut and hanger rod shall have rounded corners, edges beveled, and burrs removed. If field cutting the strut is required, use clean, sharp, dedicated tools. Remove oil, shavings, and other residue of cuttings prior to installation.
2. Coatings: To prevent corrosion:
 - a. Coat cut edges with epoxy-base touchup paint.
 - b. Coat cut edges with zinc-rich paint.

+ + END OF SECTION + +

SECTION 26 05 33.13

RIGID CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install conduit and fittings to form complete, coordinated and grounded raceway systems.
2. When specific, detailed conduit routings for various systems within buildings and other areas are not be shown on the Drawings, CONTRACTOR shall establish routings based on single-line, riser, and interconnection diagrams and other information on the Drawings. CONTRACTOR shall provide for the proper installation of conduits in each system.
3. Conduit types and the installation methods shall comply with the following, unless otherwise shown or indicated in the Contract Documents:
 - a. Use steel conduit (rigid steel or intermediate metallic) for exposed indoor conduit runs in non-corrosive areas.
 - b. Use PVC-coated rigid steel conduit for exposed interior or exterior conduit runs in hazardous, wet, and corrosive locations.
 - c. Use PVC-coated rigid steel conduit for individual conduits direct-buried in the ground.
 - d. Use Schedule 40 PVC or steel conduit for concrete-encased duct bank runs.
 - e. Use steel or Schedule 40 PVC conduit for conduit runs embedded in structural concrete slabs.
 - f. Use steel conduit for plant monitoring and control (PMCS) systems, system control and data acquisition (SCADA) systems, and communication systems, regardless of the installation. Conduit shall be PVC-coated rigid steel in hazardous, wet, and corrosive locations.

B. Coordination:

1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, light fixtures, and other systems and equipment and locate to avoid interferences.
2. For conduits to be embedded in concrete slabs, confirm adequate slab thickness and coordinate location of conduits with placement of reinforcing steel, waterstops, expansion joints, and other features of the concrete slab.

C. Related Sections:

1. Section 31 23 05, Excavation and Fill.
2. Section 32 12 00, Flexible Paving.
3. Section 05 05 33, Anchor Systems.
4. Section 26 05 29, Hangers and Supports for Electrical Systems.
5. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI C80.1, Standard for Rigid Electrical Steel Conduit (ERSC).
 - 2. ANSI/NEMA FB1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
 - 3. NEMA TC2, Electrical Polyvinyl Chloride (PVC) Conduit.
 - 4. NEMA TC3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - 5. NEMA TC14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
 - 6. UL 6, Electrical Rigid Metal Conduit – Steel.
 - 7. UL 514B, Conduit, Tubing, and Cable Fittings.
 - 8. UL 651, Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings.
 - 9. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
 - 10. UL 1242, Electrical Intermediate Metal Conduit – Steel.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 342, Intermediate Metal Conduit
 - 2. NEC Article 344, Rigid Metal Conduit.
 - 3. NEC Article 352, Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Assembly details of conduit racks and other conduit support systems.
 - b. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete, and conduits directly buried in the ground. Shop Drawings shall show locations of pull and junction boxes and penetrations in walls and floors. Shop Drawings of embedded conduits shall include cross-sections showing thickness of concrete slabs and locations of conduits relative to reinforcing steel, waterstops, and other features of the slab.
 - 2. Product Data:
 - a. Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.
- B. Informational Submittals: Submit the following:
 - 1. Manufacturer's Instructions:
 - a. When requested by ENGINEER, provide copies of manufacturer's recommendations for handling and installing products.
 - 2. Site Quality Control Submittals:
 - a. When requested by ENGINEER, provide copies of results of specified Site quality control testing.
- C. Closeout Submittals: Submit the following:
 - 1. Record Drawings:

- a. Show actual routing of exposed and concealed conduit runs in record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Rigid Steel Conduit, Elbows, and Couplings:
 1. Manufacturers: Provide products of one of the following:
 - a. Allied Tube and Conduit.
 - b. Wheatland Tube Company.
 - c. Western Tube and Conduit Corporation.
 - d. Or equal.
 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
- B. PVC-coated Rigid Steel Conduit, Elbows, and Couplings:
 1. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.
 3. Color: Color of coating shall be the same on all conduit and fittings.
- C. Intermediate Metallic Conduit, Elbows, and Couplings: (Not Used)
- D. Aluminum Conduit, Elbows, and Couplings: (Not Used)
- E. Metallic Conduit Fittings, and Outlet Bodies:
 1. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
 2. Material and Construction: Cast gray iron alloy, cast malleable iron or aluminum bodies and covers consistent with conduit material. Units shall be threaded type with five full threads. Materials shall comply with ANSI/NEMA FB1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
 3. Use: Conduits shall be gasketed and watertight in hazardous, wet, and corrosive locations.
- F. PVC-coated Conduit Fittings, and Outlet Bodies:
 1. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.

2. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers with factory coating of 40-mil thick PVC and smooth urethane interior coating. Units shall be threaded type with five full threads. Material shall comply with ANSI/NEMA FB1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
 3. Use: Provide PVC-coated or aluminum conduit fittings and outlet bodies in hazardous, wet, and corrosive locations. Fitting material shall be consistent with conduit material.
- G. Non-metallic Conduit and Fittings:
1. PVC Plastic Conduit:
 - a. Manufacturers: Provide products of one of the following:
 - 1) Amoco Chemicals Corp.
 - 2) Carlon Electrical Products.
 - 3) Or equal.
 - b. Material: Schedule 40 PVC, rated for 90 degrees C, complying with NEMA TC3 and UL 514B and 651.
 - c. Fittings: Form elbows, bodies, terminations, expansions, and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.
 2. Fiberglass Conduit: (Not Used)
- H. Conduit Hubs:
1. Manufacturers: Provide products one of the following.
 - a. Myers Electrical Products Company.
 - b. Or equal.
 2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw.
 3. Use: Provide for all conduit terminations to boxes, cabinets, and other enclosures in areas designated as wet locations.
- I. PVC-coated Conduit Hubs:
1. Manufacturers: Provide products one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw, and factory coating of 40-mil thick PVC and smooth urethane interior coating.
 3. Use: Provide for PVC-coated steel or aluminum conduit terminations to boxes, cabinets, and other enclosures in areas designated as corrosive location.
- J. Conduit Bushings and Locknuts:
1. Manufacturers: Provide products one of the following:
 - a. O-Z/Gedney.
 - b. Appleton Electric Company.
 - c. Or equal.

2. Insulated Bushings: Malleable iron body with plastic liner. Threaded type with steel clamping screw. Provide with bronze grounding lug, as required.
3. Locknuts: Steel for sizes 3/4-inch through two-inch diameter and malleable iron for sizes 2.5-inch through four-inch diameter.
4. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures except threaded type in areas designated as dusty locations.

K. Thruwall Seals

1. For new construction through exterior subsurface walls and exterior concrete walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type WSK and WSCS by O-Z/Gedney.
 - 2) Or equal.
2. For new construction passing through concrete floors and floor slabs.
 - a. Manufacturer: Provide one of the following:
 - 1) Type FSK and FSCS floor seals by O-Z/Gedney.
 - 2) Or equal.
3. For conduits passing through new exterior masonry block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs ,and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior masonry block walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
 - 2) Or equal.

2.2 ACCESSORIES

- A. Fasteners: To the extent possible, fastener material shall be consistent with conduit material. For PVC-coated rigid steel conduit runs, fasteners shall have factory applied PVC coating or be stainless steel. Fasten raceway systems to supporting structures using the following:
 1. To Wood: Wood screws.
 2. To Hollow Masonry Units: Toggle bolts, in accordance with Section 05 05 33, Anchor Systems.
 3. To Brick Masonry: Expansion bolts by Price, or equal.
 4. To Concrete: Anchors in accordance with Section 05 05 33, Anchor Systems.
 5. To Steel: Beam clamps in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.
- B. Duct Sealing Compound
 1. Soft, fibrous, slightly tacky, non-hardening sealing compound.
 2. Remains workable at all temperatures.
 3. Manufacturer:
 - a. Type DUX by O-Z/Gedney.
 - b. Or equal.

2.3 IDENTIFICATION

A. Conduit Labels:

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1. Provide conduit labels in accordance with Section 26 05 53, Identification for Electrical Systems.
- B. Warning Tape:
 1. Provide warning tape in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install in accordance with Laws and Regulations.
- B. Supports:
 1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.
 2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.
- C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.
- D. Exposed Conduit:
 1. Install parallel or perpendicular to structural members or walls.
 2. Where possible, run in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
 3. Install on structural members in protected locations.
 4. Locate clear of interferences.
 5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.
 6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.
- E. Conduit Embedded in Structural Concrete:
 1. Run embedded conduit in structural concrete in center of slabs and walls and above waterstops. Conduit connections shall be made watertight.
 2. Before placing concrete, arrange for observation of conduit installation by RPR or ENGINEER and make necessary conduit location measurements and provide required information on record documents.
 3. Confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown or indicated otherwise, embedded conduits shall be in accordance with the following criteria:

- a. Minimum concrete thickness shall be as follows:
 - 1) For concrete 16 inches thick and less, minimum concrete thickness shall be 11.5 inches plus the depth of largest conduit assembly. Conduit assembly depth shall be from the top of uppermost conduit to bottom of lowest conduit.
 - 2) For concrete greater than 16 inches thick, minimum concrete thickness shall be 13.5 inches plus depth of largest conduit assembly.
 - 3) For concrete at foundation slabs, provide a one inch additional to minimum concrete thicknesses specified.
 - b. Conduit spacing shall be as follows:
 - 1) Two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of larger conduit
 - 2) When conduits cross at a point, conduits may be in direct contact and angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of multi-conduit layer assembly.
 - 3) When conduits cross structural expansion joint, two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of conduit fitting of the larger conduit
- F. Underground Conduits:
- 1. Install individual, underground conduits minimum of 20 inches below grade, unless otherwise shown or indicated.
 - 2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Section 31 23 05, Excavation and Fill.
 - 3. Install warning tape 12 inches below finished grade over buried conduits.
- G. Empty Conduits:
- 1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.
- H. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.
- I. Joints:
- 1. Apply conductive compound to joints before assembly.
 - 2. Make up joints tight and ground thoroughly.
 - 3. Use standard tapered pipe threads for conduit and fittings.
 - 4. Cut conduit ends square and ream to prevent damaging wire and cable.
 - 5. Use full threaded couplings. Split couplings are not allowed.
 - 6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
 - 7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where base metal is exposed.
- J. Terminations:
- 1. Install insulated bushings on conduits entering boxes or cabinets, except when threaded hubs are used.
 - 2. Provide locknuts on both inside and outside of enclosure, except when threaded hubs are used.

3. Use of bushings in lieu of locknuts is not allowed.
 4. Install conduit hubs on conduits entering boxes or cabinets in wet and corrosive areas.
- K. Moisture Protection:
1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
 2. Underground and embedded conduit connections shall be watertight.
 3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.
 4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
 5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.
- L. Corrosion Protection:
1. Conduit Curb:
 - a. For conduits routed in concrete slabs or floors and stub-ups through floor, provide four inch high concrete curb, extending two inches from outer surface of conduit penetrating floor, to prevent corrosion. For floor-mounted equipment, concrete equipment base shall be in lieu of concrete curb.
 - b. Conduit stub-ups shall be 90-degree, PVC-coated, rigid, galvanized steel conduit elbow. PVC-coated elbow shall extend a minimum of 1/2-inch above top of concrete curb or equipment base. Should elbow not reach specified height, provide PVC-coated conduit extension to accommodate specified requirements. Provide coupling or fitting for transition from rigid galvanized steel conduit or PVC conduit in slab to PVC-coated elbow.
 - c. For conduits stubbing up and terminating at equipment enclosure mounted on concrete base, provide insulated grounding bushing on PVC-coated rigid steel elbow.
 - d. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb in wet and dusty areas, provide conduit coupling/fittings between the PVC-coated rigid steel elbow and rigid steel conduit for transition between the two conduit types.
 - e. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb or equipment base in corrosive areas, continue conduit system with PVC-coated rigid steel conduit
 2. Dissimilar Metals:
 - a. Prevent occurrence of electrolytic action between dissimilar metals.
 - b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.
 - c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.
- M. Reused Existing Conduits:

1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
 2. Repeat swabbing until all foreign material is removed.
 3. Pull mandrel through conduit, if necessary, to remove obstructions.
- N. Core drill for individual conduits passing through existing concrete slabs and walls. Notify ENGINEER in writing in advance of core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit as indicated in Paragraph 3.2.K.3 of this Section.
- O. Non-metallic Conduit:
1. Install in accordance with manufacturer's recommendations.
 2. Provide manufacturer's recommended adhesives or sealants for watertight connections.
 3. Provide expansion fittings for expansion and contraction to compensate for temperature variations. Fittings shall be watertight and suitable for direct burial.
 4. Transition to PVC-coated rigid steel conduit before making turn up to enclosures.
- P. PVC-coated Rigid Steel Conduit:
1. Install in accordance with manufacturer's recommendations.
 2. Install with manufacturer's installation tools to avoid damage to PVC coating.
 3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.
- Q. Identify conduits, including spares, in accordance with Section 26 05 53, Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

- A. Site Tests:
1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduit's inside diameter.
 2. Maintain a record, by number, of all conduits successfully tested.
 3. Repair or replace conduits that do not successfully pass testing, and re-test.

+ + END OF SECTION + +

SECTION 26 05 33.16

FLEXIBLE CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install flexible metallic conduit and fittings.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 360, Liquid-Tight Flexible Steel Conduit.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 350, Liquid-Tight Flexible Metal Conduit.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's literature and technical information for flexible conduit and fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Flexible Conduit (Non-hazardous Areas and Class 1, Division 2, Hazardous Areas):
 - 1. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1.25-inch. Material shall be UL-listed.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Anaconda Sealtite Type UA by Anamet Electrical, Inc.
 - b. Liqueflex Type L.A. by Electric-Flex Company.
 - c. Or equal.
- B. Flexible Conduit (Class 1, Group D, Division 1, Hazardous Areas):
 - 1. Material: Flexible brass inner core with bronze outer braid and protective neoprene plastic coating. Steel, brass, or bronze end fittings. Minimum of 12 inches long.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Type ECGJH or ECLK by Crouse Hinds Company.
 - b. Type EXGJH or EXLK by Appleton Electric Company.
 - c. Or equal.

- C. Flexible Conduit Fittings:
1. Material and Construction: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
 2. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
 3. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.
- D. PVC-Coated Conduit Fittings:
1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections, and shall have an inside diameter not less than that of the corresponding standard conduit size.
 2. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Permacote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 3. Use: Provide on flexible conduit in areas designated as corrosive locations.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install at motors, transformers, field instruments, and equipment subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch diameter flexible conduit. Limit flexible conduit length to three feet maximum.
- B. Install in conformance with the Laws and Regulations.

+ + END OF SECTION + +

SECTION 26 05 33.23

SEALED FITTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit sealing fittings with sealing fiber and sealing compound.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations, Class 1, Groups A, B, C and D and Class II, Groups E, F and G.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 500, Hazardous (Classified) Locations.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of locations where fittings are to be used.
 - 2. Product Data:
 - a. Manufacturer's literature and technical information for sealing fittings, sealing fiber, and sealing compound proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Provide products of one of the following:
 - 1. Crouse Hinds Company.
 - 2. Appleton Electric Company.
 - 3. Or equal.
- B. Materials and Construction:
 - 1. Cast gray iron alloy, or cast malleable iron, or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish.
 - 2. Ample opening with threaded closure for access to conduit hub for making dam.
 - 3. In corrosive locations, fittings shall include factory-applied 40-mil PVC coating.
 - 4. Construct fitting to allow 40 percent cross-sectional fill.

- C. Sealing fiber for forming the dam within the hub and sealing compound shall be suitable for use with fittings furnished and shall be products of fitting manufacturer.
- D. Sealing fitting, fiber, and sealing compound shall conform to UL 886.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install for hazardous locations as required by Laws and Regulations and as shown.
- B. Provide fittings for proper use relative to mounting position.
- C. Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

+ + END OF SECTION + +

SECTION 26 05 33.26

EXPANSION/DEFLECTION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit expansion and deflection fittings.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 514B, Conduit, Tubing, and Cable Fittings.
 - 2. UL 467, Grounding and Bonding Equipment.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 300, Wiring Methods.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of locations where fittings are required.
 - 2. Product Data:
 - a. Manufacturer's literature and technical information for expansion and deflection fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Products and Manufacturers: Provide one of the following:
 - 1. Type DX for expansion/deflection or AX for expansion only, by O-Z Gedney Company.
 - 2. Type XD for expansion/deflection or XJ for expansion only, by Crouse Hinds Company.
 - 3. Type DF for expansion/deflection or XJ for expansion only, by Appleton Electric Company.
 - 4. Or equal.
- B. Cast gray iron alloy or bronze end couplings, malleable iron, or hot-dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting shall be watertight, corrosion-resistant, UL-listed, and compatible with the conduit system.
- C. Features:
 - 1. Expansion/Deflection Fittings:
 - a. Axial expansion or contraction up to 3/4-inch.

- b. Angular misalignment up to 30 degrees.
 - c. Parallel misalignment up to 3/4-inch.
- 2. Expansion Fittings:
 - a. Expansion/Contraction: Eight-inch total movement.

D. Expansion/Deflection fittings shall comply with UL 514B and UL 467.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install fittings in accordance with Laws and Regulations.
- B. Provide expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Provide expansion fittings on exposed conduit runs exceeding 200 feet.
- C. Provide expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Provide fittings above waterstops.
- D. Unless specifically shown or indicated otherwise, when crossing structural expansion joints larger than one inch, provide expansion fitting together with expansion/ deflection fitting. Install fittings on each conduit run in accordance with manufacturer's recommendations to accommodate additional movement necessary.
- E. Provide expansion/deflection fittings for underground conduit runs at penetrations of buildings, manholes, handholes, and outdoor concrete equipment pads.
- F. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid-to-PVC adapters for connection to fittings. Ensure that joints exposed to water or other liquid are made watertight.

+ + END OF SECTION + +

SECTION 26 05 33.33

PULL, JUNCTION, AND TERMINAL BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 29, Hangers and Supports for Electrical Systems.
 - 3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are.
 - 1. AASHTO, Standard Specifications for Highway Bridges.
 - 2. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's technical information for pull, junction, and terminal boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Pull, Junction, and Terminal Boxes:
 - 1. General – Applicable to All Boxes:
 - a. Description and Performance Criteria:
 - 1) Provide pull, junction, and terminal boxes rated at not less than NEMA 12. Boxes shall be appropriate for each location in accordance with NEMA requirements and as required for area

classifications specified in Section 26 05 05, General Provisions for Electrical Systems.

- 2) For flush-mounted pullboxes in slabs or pavement potentially subject to vehicular traffic, boxes and covers shall be constructed for H-20 loading in accordance with AASHTO Standard Specifications for Highway Bridges.
 - b. Manufacturers: Provide products of one of the following:
 - 1) Appleton Electric Company.
 - 2) Crouse-Hinds Company.
 - 3) Hoffman Engineering Company.
 - 4) Or equal.
 - c. Materials: Pull boxes embedded in concrete slabs shall be cast iron.
 - d. Terminal strips and terminal blocks in terminal boxes shall be mounted on terminal box sub-panels.
 - e. Identification: Boxes shall be identified in accordance with Section 26 05 53, Identification for Electrical Systems.
2. Materials and Construction – Dusty Locations:
 - a. Material: Welded and galvanized sheet steel of USS gage.
 - b. Gasket: Oil-resistant gasket.
 - c. Access: Lift-off hinges and quick-release latches.
 - d. Material Thickness:
 - 1) Boxes with dimension two feet and smaller shall be 14-gage.
 - 2) Boxes with dimension between two and three feet shall be 12 gage.
 - 3) Boxes with dimension of three feet or more in any direction shall be 10-gage.
 3. Materials and Construction - Wet, Corrosive, or Hazardous Locations:
 - a. Rating:
 - 1) Pull boxes in wet, corrosive, or outdoor areas shall be NEMA 4X.
 - 2) Boxes for areas classified as hazardous locations, where required by NEC, shall be explosion-proof and comply with UL 886.
 - b. Material:
 - 1) Cast gray iron alloy with hot-dip galvanized finish, or cast malleable iron bodies and covers.
 - 2) Large boxes not generally available in cast iron construction shall be copper-free aluminum alloy or Type 316 stainless steel, as required by location.
 - 3) In corrosive locations, where the conduit system is PVC-coated, boxes shall be cast metal with factory-applied 40-mil PVC coating, Type 316 stainless steel, or non-metallic thermoplastic or fiberglass reinforced plastic material.
 - c. Gasket:
 - 1) Provide neoprene gaskets for wet and corrosive locations.
 - 2) Gaskets shall be an approved type designed for the purpose. Improvised gaskets are not acceptable.

- d. Access: Stainless steel cover bolts.
 - e. Features:
 - 1) External mounting lugs.
 - 2) Drilled and tapped conduit holes.
 - 3) Boxes where conduits enter building or structure below grade shall have 1/4-inch drain hole at bottom of the box.
 - 4) Provide threaded connections for explosion proof boxes.
- B. Terminal Blocks:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Allen-Bradley Company, Bulletin, Model 1492.
 - b. General Electric Company, Model CR151K.
 - c. Or equal.
 - 2. Material and Construction:
 - a. NEMA-rated nylon modular terminal blocks.
 - b. 600-volt rated.
 - c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
 - d. Power terminals shall be copper and rated for the circuit ampacity.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Mount boxes so that sufficient access and working space is provided and maintain clearance of not less than 1/4-inch from walls.
- B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes will not be mounted on walls or other structural surface.
- C. Install pull boxes where shown or indicated, and provide pull boxes where one or more of the following conditions exist:
 - 1. Conduit runs containing more than three 90-degree bends.
 - 2. Conduit runs exceeding 200 feet in length.
- D. Provide removable, flame-retardant, insulating cable supports in boxes with any dimension exceeding three feet.
- E. Field-apply PVC touch-up to scratched PVC boxes damaged during installa-

tion. Touch-up work shall be in accordance with manufacturer's recommendations and instructions.

- F. Size junction, pull, and terminal boxes in accordance with NEC Article 314 and other Laws and Regulations.
- G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

+ + END OF SECTION + +

SECTION 26 05 33.36

OUTLET BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install outlet boxes for mounting wiring devices and lighting fixtures.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 29, Hangers and Supports for Electrical Systems.
 - 3. Section 26 05 53, Identification for Electrical Systems.
 - 4. Section 26 27 26.13, Low-Voltage Receptacles.
 - 5. Section 26 27 26.23, Snap Switches.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Fittings; and Handhole Enclosures.
 - 2. NEC Article 501, Class I locations.
 - 3. UL 514A, Metallic Outlet Boxes.
 - 4. UL 514B, Fittings for Conduit and Outlet Boxes.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's technical information for outlet boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Device Boxes:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
 - 2. Material:
 - a. In Wet Locations: Cast gray iron alloy or cast malleable iron with zinc electroplate finish, or aluminum bodies consistent with conduit material.
 - b. In Dusty Locations: Zinc-coated sheet steel or aluminum bodies consistent with conduit material.
 - c. Where conduit is installed concealed, boxes shall include suitable extension rings and covers, as required.

- d. Where used with PVC-coated conduit system, boxes shall include factory applied 40-mil-thick PVC coating.
 - e. Cast boxes shall be hub-type and include external mounting lugs.
 - f. Metallic outlet boxes shall comply with UL 514A.
 - g. Fittings for outlet boxes shall comply with UL 514B.
 - 3. NEMA rating of box shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
 - 4. Cover Plates:
 - a. Type 302 stainless steel alloy for indoor finished areas.
 - b. Plates in corrosive locations shall include factory-applied 40-mil PVC coating.
 - c. Stainless steel screws and hardware.
 - d. For receptacle and switch cover plates, comply with Section 26 27 26.13, Low-Voltage Receptacles, and Section 26 27 26.23, Snap Switches.
- B. Flexible Fixture Hangers:
- 1. For Class I, Division 1 Hazardous Areas:
 - a. Product and Manufacturers: Provide one of the following:
 - 1) Type EFH by Crouse-Hinds.
 - 2) Or equal
 - b. Materials:
 - 1) Iron alloy with electro-galvanizing and aluminum acrylic paint.
 - 2) Products shall have brass bellows and stainless steel spring.
 - 3) Product shall be capable of 15 degree swing from perpendicular in all directions.
 - 4) Product shall allow fixtures to be pendant-hung in accordance with NEC Article 501.130(A)
 - 2. For Class I, Division 2 Hazardous Areas:
 - a. Product and Manufacturers: Provide one of the following:
 - 1) Type AHG by Crouse-Hinds.
 - 2) Or equal
 - b. Materials:
 - 1) Malleable iron top section and removable malleable iron bottom fixture support assembly with electro-galvanizing and aluminum acrylic paint.
 - 2) Include vapor-tight cushion to support fixture stem.
 - 3) Provide neoprene diaphragm to exclude moisture and dirt from conduit system.
 - 4) Provide with manufacturer's neoprene gasket between fixture hanger and box.
 - 5) Product shall be capable of eight-degree swing from perpendicular in all directions, before and after coating.
 - 6) Product shall allow fixtures to be pendant-hung in accordance with NEC Article 501.130 (B).

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are

corrected.

3.2 INSTALLATION

- A. Fasten boxes rigidly and neatly to supporting structures.
- B. Securely fasten equipment to walls or other surfaces on which materials or equipment is mounted. Provide independent supports complying with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes are not mounted on walls or other surface capable of supporting the materials or equipment.
- C. For units mounted on masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.
- D. Leave no open conduit holes in boxes. Close unused openings with capped bushings.
- E. Label each circuit in boxes and identify each circuit in accordance with Section 26 05 53, Identification for Electrical Systems.
- F. Install outlet boxes in accordance with NEC Article 314.

+ + END OF SECTION + +

SECTION 26 05 43.13

UNDERGROUND DUCTBANKS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install underground ductbanks.
- B. Coordination:
 - 1. Ductbank routing on the Drawings is diagrammatic. Coordinate installation with piping and other Underground Facilities and locate ductbanks clear of interferences.
 - 2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before underground ductbank Work.
- C. Related Sections:
 - 1. Section 31 23 05, Excavation and Fill.
 - 2. Section 03 00 05, Concrete.
 - 3. Section 26 05 26, Grounding and Bonding for Electrical Systems.
 - 4. Section 26 05 53, Identification for Electrical Systems.
 - 5. Section 26 05 33.13, Rigid Conduits.

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Layouts showing proposed routing of ductbanks and locations of manholes, handholes, and areas of reinforcement.
 - b. Profiles of ductbanks showing crossings with piping and other Underground Facilities.
 - c. Typical cross sections for each ductbank.
- B. Informational Submittals: Submit the following:
 - 1. Special Procedure Submittals:
 - a. Installation procedures.
 - 2. Field Quality Control Submittals:
 - a. Field test report.
- C. Closeout Submittals: Submit the following:
 - 1. Record Drawings:
 - a. Include actual routing of underground ductbank runs on record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

Home Depot MPS and FM
Underground Ductbanks for
Electrical Systems
30036073

NOT USED

2.1 MATERIALS

- A. Duct: Provide conduit and fittings in accordance with Section 26 05 33.13, Rigid Conduits. Conduit types shall be as follows:
 - 1. Schedule 40 PVC conduits for power circuits.
 - 2. Galvanized rigid steel conduits for the following types of circuits: low voltage status, analog, and communication.
- B. Backfill: Provide backfill, including select backfill, in accordance with Section 31 23 05, Excavation and Fill.
- C. Concrete: Provide ductbank concrete in accordance with Section 03 00 05, Concrete.
- D. Grounding: Provide ground cable in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.
- E. Conduit Spacers: Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Provide spacers suitable for all conduit types used in multiple sizes.
- F. Duct Sealing Compound:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. O-Z/Gedney, Type DUX.
 - b. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Excavation and Backfilling:
 - 1. Provide excavation and backfilling for ductbank installation in accordance with Section 31 23 05, Excavation and Fill.
 - 2. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can damage or contribute to corrosion of ducts or cables, or prevent adequate compaction of backfill.
- B. Ductbank Layout:
 - 1. Top of ductbank concrete shall be a minimum of 2.5 feet below grade, unless shown or indicated otherwise on the Drawings.

2. Slope ductbank runs for drainage toward manholes and away from buildings with slope of approximately three inches vertical per 100 feet of run.
- C. Ductbank Assembly:
1. Assemble ductbanks using non-magnetic saddles, spacers, and separators. Position separators to provide minimum three-inch concrete separation between outer surfaces of each conduit. Provide side forms for each ductbank.
 2. Make bends with sweeps of not less than four-foot radius or five-degree angle couplings.
- D. Concrete Placing:
1. Provide minimum four-inch concrete covering on each side, top, and bottom of concrete envelopes around conduits. Concrete covering shall be as shown or indicated on the Drawings.
 2. Provide red dye in concrete for easy identification during subsequent excavation; all concrete in entire ductbank, including top and bottom, shall be dyed.
 3. Firmly fix conduits in place during concrete placing. Carefully place and vibrate concrete to fill spaces between conduits.
- E. Conduit Transitions:
1. Conduit installations shall be watertight throughout entire length of ductbank.
 2. Transition from non-metallic to galvanized rigid steel conduit where ductbanks enter structure walls and slabs.
 3. Terminate conduits in insulated grounding bushings.
 4. Continue conduits inside buildings in accordance with Section 26 05 33.13, Rigid Conduits, and as shown or indicated in the Contract Documents.
 5. If ducts are not concrete-encased, provide expansion and deflection fittings in accordance with Section 26 05 33.26, Expansion/Deflection Fittings.
 6. Plug and seal empty spare conduits entering structures. Conduits in use entering structures shall be sealed watertight with duct sealing compound.
- F. Ductbank Reinforcing:
1. Provide reinforcing for all ductbanks:
 2. Install ductbank reinforcement as shown or indicated on the Drawings.
 3. Provide maximum clearance of 1.5 inches from bars to edge of concrete encasement.
- G. Connections to Structures:
1. Firmly anchor ductbanks to structure walls or slabs. Epoxy-grout ductbank rebar into structure concrete to eliminate shear forces between ductbank and structure wall concrete.
 2. Ductbank penetrations through structure walls shall be watertight.
- H. Grounding:

1. Provide bare stranded copper ductbank ground cable in each ductbank envelope. Make ground electrically continuous throughout entire ductbank system.
 2. Connect ground cable to building and station ground grid or to equipment ground buses. Also, connect ground cable to steel conduit extensions of underground ductbank system.
 3. Provide ground clamp and bonding of each steel conduit extension to maintain continuity of ground system.
 4. Terminate ground cable at last manhole or handhole for outlying structures.
- I. Detectable Underground Warning Tape:
1. Provide detectable underground warning tapes complying with Section 26 05 53, Identification for Electrical Systems, over the full length of each underground ductbank.
 2. Install warning tapes approximately 12 inches below grade.
 3. Provide multiple tapes across the width of each ductbank. Locate center of a warning tape above each edge of ductbank, and at intervals across top width of ductbank so that clear space between tapes does not exceed six inches.
- J. Reused Existing Ducts:
1. Pull rag swab through duct to remove water and to clean conduits prior to installing new cable.
 2. Repeat swabbing until all foreign material is removed.
 3. Pull mandrel through duct, if necessary, to remove obstructions.

+ + END OF SECTION + +

COMPLSECTION 26 05 43.23

HANDHOLES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install handholes for electrical systems Work.
- B. Coordination:
 - 1. Coordinate handhole installation with piping, sheeting other excavation supports, and other Underground Facilities, and locate clear of interferences.
 - 2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before handhole for electrical systems Work.
- C. Related Sections:
 - 1. Section 31 23 05, Excavation and Fill.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. AASHTO, Specifications for Highway Bridges.
 - 2. ANSI A14.3, Fixed Ladders – Safety Requirements.
 - 3. ANSI/SCTE 77, Specification for Underground Enclosure Integrity.
 - 4. ASTM A48/A48M, Specification for Gray Iron Castings.
 - 5. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - 6. ASTM C1028, Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
 - 7. ASTM D4101, Specification for Polypropylene Injection and Extrusion Materials

1.3 QUALITY ASSURANCE

- A. Component Supply and Compatibility:
 - 1. Obtain all handholes furnished under this Section from a single Supplier, unless otherwise acceptable to ENGINEER.
 - 2. Handhole Supplier shall review and approve the Shop Drawing submittals for the handholes furnished.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Handholes: Submit schedule of handholes to be furnished and dimensions and pertinent data for each.

2. Product Data:
 - a. Manufacturer's technical information, specifications, and literature for handholes and accessories proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

NOT USED

2.2 SMALL HANDHOLES

- A. Material and Construction:
 1. Manufacturer: Provide products of one of the following:
 - a. Strongwell Quazite
 - b. Or equal
 2. Material: Precast polymer concrete.
 3. Duct entrances sized and located to suit ductbanks.
 4. Enclosures and covers shall be UL-listed.
 5. Enclosures, boxes, and covers shall comply with test provisions of ANSI/SCTE 77 for Tier 15 applications.
 6. Covers shall have coefficient of friction of not less than 0.50, in accordance with ASTM C1028.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Excavation and Backfill:
 1. Provide handholes for electrical systems where shown or indicated and verify at the Site the required locations.
 2. Perform excavation and filling required for installing handholes for electrical systems, in accordance with Section 31 23 05, Excavation and Fill.
 3. Provide handholes on granular subbase course as shown or indicated. If not shown, provide layer of compacted select fill not less than six inches deep on which handhole for electrical systems will be installed.
 4. Carefully set, level, and align at proper grade handholes.
- B. Handhole structures shall be watertight. Provide foam sealant to seal all penetrations into handholes for electrical systems.
- C. Metal Pull Box:
 1. Provide NEMA 4X, stainless steel, wall-mounted pull box inside each handhole for electrical systems where analog signal cables are mixed with power cables.

2. Route conduits for analog cables directly into and out of metal pull box so that analog cables are not exposed.
- D. Grading at Handholes:
1. Unpaved Areas:
 - a. Install handholes in unpaved areas as shown or directed by ENGINEER to rim elevation higher than finished grade.
 - b. Grade the ground surface to drain away from handholes.
 - c. Provide fill around handholes to level of upper rim of handhole frame, and evenly grade the surface to a one (vertical)-to-five (horizontal) slope to surrounding grade, unless otherwise shown or directed by ENGINEER.
 2. Paved or Travelled Areas:
 - a. Install handholes in paved or travelled areas to meet final grade of paved or concrete surface.
 - b. In paved areas in state or county highways or municipal streets or roads, handholes shall be 1/2-inch below elevation of final surface course (also known as top course or wearing course) of pavement.
 - c. Handholes shall not project above finished roadway pavement.
 3. CONTRACTOR shall be solely responsible for proper height of handholes necessary to reach final grade. ENGINEER's review of Shop Drawings and other submittals for handholes is general in nature.

3.3 FIELD QUALITY CONTROL

- A. Watertightness:
1. Handholes for electrical systems shall be free of visible leakage. Inspect each handhole accompanied by ENGINEER, and repair leaks.

+ + END OF SECTION + +

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.
- B. Related Sections:
 - 1. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 110, Requirements for Electrical Installation.
 - 2. NEC Article 210, Branch Circuits.
 - 3. NEC Article 215, Feeders.
 - 4. NEC Article 504, Intrinsically Safe Systems.
 - 5. NEC Article 700, Emergency Systems.
 - 6. NEC Article 701, Legally Required Standby Systems.
 - 7. NEC Article 702, Optional Standby Systems.
 - 8. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
 - 9. NFPA 70E, Electrical Safety in the Workplace.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings: Submit the following:
 - a. Complete description and listing of proposed electrical identification and electrical identification devices for associated equipment or systems.
 - b. Conduit and wire identification numbering system and equipment signage.
 - 2. Product Data:
 - a. Manufacturer's literature, cut sheets, specifications, dimensions and technical data for all products proposed under this Section.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

- A. Engraved Identification Devices (Nameplates and Legend Plates):
 - 1. Nameplates:
 - a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
 - b. Size: As required.

- c. Letter Size: Minimum 3/16-inch.
 - d. Nameplates one-inch or less in height shall have one mounting hole at each end. Nameplates greater than one-inch in height shall have mounting holes in the four corners.
 - 2. Legend Plates:
 - a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
 - 1) Provide standard-size legend plates where devices are mounted on motor control centers and spacing of devices precludes using automotive-size legend plates.
 - b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.
- B. Safety Signs and Voltage Markers:
- 1. Low-Voltage Safety Signs:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-86060 by Brady.
 - 2) Or equal.
 - b. Low voltage safety signs shall be pressure-sensitive vinyl complying with 40 CFR 1910.145, five inches by 3.5 inches in size, and shall read, "DANGER – 480 VOLTS".
 - 2. Low-Voltage Markers:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) CV442xx by Brady.
 - 2) Or equal.
 - b. Low voltage markers shall be either pressure-sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, "120 VOLTS", "208 VOLTS", "120/208 VOLTS", or "240 VOLTS" as required.
- C. Arc-flash Safety Signs:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Brady.
 - b. Or equal.
 - 2. Warning signs shall be adhesive-backed polyester.
 - 3. Warning signs shall read, "Warning – Arc Flash and Shock Hazard. Appropriate PPE Required. Arc flash warning signs shall indicate the flash protection boundary, incident energy in calories per square centimeter, hazard level, description of required protective clothing, shock hazard, limited approach boundary, restricted approach boundary, prohibited approach boundary, and equipment name.
- D. Voltage System Identification Directories:
- 1. General:
 - a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
 - b. Directories shall identify all voltage systems within building or structure.

- c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
- d. Colors shall be in accordance with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
- e. Example Directory Text:

Voltage System Identification		
System	A, B, C	Neutral
277/480	Brown, Orange, Yellow	Gray
120/208	Black, Blue, Red	White

2. Large directories for rooms shall have text height not less than 1/2-inch.
3. Small directories for equipment shall have text height of not less than 1/4-inch.

E. Conduit Labels:

1. Products and Manufacturers: Provide one of the following:
 - a. B-915-xxxxx by Brady.
 - b. Or equal.
2. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit for conduit up through five-inch diameter, or pre-molded to conform to circumference of conduit six-inch diameter and larger.
3. Attach strap-on style for six-inch diameter conduit with stainless steel springs.
4. Shall be blank for use with custom printed labels.
5. Custom Labels:
 - a. Shall have black lettering on yellow background.
 - b. Shall not contain abbreviations in legend.
 - c. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.

F. Wire Identification:

1. Heat Shrinkable Wire and Cable Labeling System:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-341 PS-xxx-2W by Brady.
 - 2) Or equal.
 - b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.
2. Wrap-Around Wire and Cable Labeling System:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) THT-XX-427 by Brady.
 - 2) Or equal.
 - b. Self-laminating white/transparent self extinguishing vinyl strips. Length shall be sufficient to provide at least 2.5 wraps. Labels shall be thermally printed and not less than two inches wide.

G. Detectable Underground Warning Tape:

1. Products and Manufacturers: Provide one of the following:
 - a. Indentoline by Brady.
 - b. Or equal.

2. Material: Polyethylene or polyester with detectable metal core and polyester underlamine.
 3. Width: Two inches.
 4. Color and Labeling: Yellow or red with permanently imprinted black letters: "CAUTION – Buried Electric Line", repeated continuously over full length of tape.
- H. Thermal Printing System:
1. Utilize thermal transfer process to provide non-smearing labels and markers.
 2. Wire and Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) TLS2200 by Brady.
 - 2) Or equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) 200M by Brady.
 - 2) Or equal.
 3. Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) Handimark by Brady.
 - 2) Or equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) Labelizer PLUS by Brady.
 - 2) Or equal.

2.2 FABRICATION

- A. Engraved Identification Devices (Nameplates and Legend Plates):
1. Nameplate and legend plate text is preliminary and subject to change pending final review and approval of nomenclature by ENGINEER after start-up and testing.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment and materials.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
 2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
 3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
 4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.

5. On switchgear, provide nameplates for each main and feeder circuit including control fuses, and for each indicating light and instrument.
 - a. Provide nameplate with 1.5-inch high letters giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number, and item number.
 - b. Identify individual door for each compartment with nameplate giving item designation and circuit number.
6. Motor Control Centers:
 - a. Provide nameplate with 1.5-inch letters with motor control center designation.
 - b. Identify individual door for each unit compartment with nameplate identifying controlled equipment.
7. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).
8. Push Buttons:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Provide red buttons for stop function.
 - d. Provide black buttons for other functions.
9. Pilot Lights:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

Color	Legend
Green	Running, Open
Red	Stopped, Closed
Amber	Alarm
Blue	Power
White	Status

10. Selector Switches:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
11. Panel Mounted Instruments:
 - a. Provide nameplates for identification of function.
12. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
 - a. Provide nameplates for identification.
 - b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved Shop Drawings and CONTRACTOR's other submittals. Install nameplates with adhesive.
 - c. Interior items requiring nameplates include:
 - 1) Terminal blocks and strips.
 - 2) Bus bars.
 - 3) Relays.
 - 4) Rear of face-mounted items.
 - 5) Rear of door-mounted items.

- 6) Interior mounted items that require identification when mounted externally.
- d. Circuit Breaker Directory:
 - 1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.
- 13. Re-label existing equipment whose designation have changed.
- C. Safety Signs and Voltage Markers:
 - 1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.
 - a. Install rigid safety signs using stainless steel fasteners.
 - b. Clean surfaces before applying pressure-sensitive signs and markers.
 - 2. Install high voltage safety signs on all equipment doors providing access to uninsulated conductors, including terminal devices, greater than 600 volts.
 - 3. Provide cable tray safety signs on both sides of cable trays at maximum intervals of 20 feet. Install signs on side rails of tray as acceptable to ENGINEER.
 - a. Label cable trays that contain conductors greater than 600 volts with cable tray safety signs.
 - b. Cable trays that contain conductors greater than 208 volts and less than 600 volts shall be labeled with low voltage safety signs.
 - c. Cable trays that contain conductors of 120/208 volts shall be labeled with low voltage markers.
 - d. Do not label cable trays that contain only instrument signal cables.
 - e. Label cable trays that contain intrinsically safe wiring or cables in accordance with NEC Article 504.
 - 4. Install low voltage safety signs on equipment doors that provide access to uninsulated 480-volt conductors, including terminal devices.
 - 5. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.
- D. Voltage System Identification Directories
 - 1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
 - 2. Provide in each electrical room voltage system identification directory mounted on wall or door at each entrance to room.
 - 3. For panelboards, switchboards, motor control centers, and other branch circuit or feeder distribution equipment that are not located in electrical rooms, provide voltage system identification directory mounted on equipment.
 - a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
 - b. Directories shall be readily visible and not obscure labels and other markings on equipment.
- E. Arc-flash Safety Signs:
 - 1. Provide arc-flash safety signs as required by NEC Article 110.
 - 2. Provide signs for switchboards, panelboards, motor control centers, and industrial control panels. Provide signs for control panels that contain

480 volt equipment. Provide arc flash warning signs on other equipment where the incident energy is greater than 1.2 calories per square centimeter.

F. Conduit Labels:

1. Provide conduits with conduit labels unless otherwise shown or indicated.
2. Do not label flexible conduit.
3. Do not label exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment.
4. Conduit labels shall indicate the following information:
 - a. System Voltage Rating
 - 1) 480 VAC
 - 2) 120 VAC
 - 3) 24 VDC
 - b. System Identification
 - 1) Power
 - 2) Control
 - 3) Analog
5. Conduits that contain intrinsically safe wiring shall have an additional pipe marker provided that has blue letters on white background and reads, "INTRINSICALLY SAFE WIRING".
 - a. Install intrinsically safe pipe markers in accordance with NEC Article 504 along entire installation. Spacing between labels shall not exceed 25 feet.
6. Provide conduit labels at the following locations:
 - a. Where each conduit enters and exits walls, ceilings, floors, or slabs.
 - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
 - c. At maximum intervals of 50 feet along length of conduit.
7. Orient conduit labels to be readable.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors shall comply with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
3. Do not provide labels for the following:
 - a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
4. Provide wire and cable labels for the following:
 - a. New, rerouted, or revised wire or cable.
 - b. Insulated conductors.
 - c. Wire and cable terminations:
 - 1) Wire labels shall be applied between 1/2-inch and one inch of completed termination
 - 2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
 - a) Label individual conductors in a cable after breakout as specified for wires.

- d. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.
 - 1) Label wires or cables within two inches of entrance to conduit.
 - e. Wire or cable in junction boxes and pull boxes
 - 1) Label wires or cables within two inches of entrance to conduit.
 - f. Wire and cable installed in cable tray.
 - 1) Wire and cable shall have labels at maximum intervals of 20 feet.
 - g. Wire and cable installed without termination in electrical manholes.
 - 1) Wire and cable shall have wrap-around labels applied within one foot of exiting manhole.
 - 5. Wire and Cable Identification System:
 - a. Wire and cable labels shall be imprinted with an identifying designator.
 - 1) Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.
 - b. Field Wiring:
 - 1) Wire or cable designator shall consist of:
 - a) Three left-most characters shall consist of the Contract number under which wiring or cable was installed.
 - b) Fourth character from the left shall be an asterisk (*), a plus sign (+) or a hyphen (-). Do not use other punctuation symbols in a wire designator.
 - c) Remaining characters shall be alphanumeric and make wire designator unique.
 - d) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.
 - c. Cabinet, Console, Panel, and Enclosure Wiring, Internal:
 - 1) New Cabinets, Consoles, Panels, and Enclosures:
 - a) Wire and cable inside cabinets, consoles, panels, and enclosures shall have designators as specified in Contract Drawings and/or Section 40.
 - 6. Modified Cabinets, Consoles, Panels, and Enclosures:
 - a. New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a ten-character designator equivalent to field wire designator.
- H. Terminal Strip Labeling:
- 1. Label panel side of terminal to match panel wire number.
 - 2. Label field side of terminal to match field wire number. Terminal number shall not include the Contract number.
- I. Generator System Warning Signs:
- 1. Provide warning signs for generator systems as required by NEC.
 - 2. Install generator location warning sign on or immediately adjacent to service equipment, or to "normal" source disconnecting means when generator is located out of sight of service equipment or disconnecting means.
 - 3. Install generator grounding warning sign on enclosure or immediately adjacent to point where generator neutral is connected to grounding electrode system if connection is made remote from generator.

+ + END OF SECTION + +

SECTION 26 05 73

ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, professional services, and incidentals required to perform electrical power distribution system studies.
2. Motor starting and transformer information used in electrical power distribution system studies shall be based on equipment provided by CONTRACTOR and, where applicable, existing equipment ratings and settings.
3. Electrical power distribution system studies shall include the following, as specified in this Section:
 - a. Short-circuit study.
 - b. Protective device evaluation study.
 - c. Protective device coordination study.
 - d. Arc flash analysis.

B. Related Sections:

1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/IEEE C37.91, Guide for Protective Relay Applications to Power Transformers
2. ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment.
3. IEEE 141, Recommended Practice for Electric Power Distribution in Industrial Plants (IEEE Red Book).
4. IEEE 242, Recommended Practice for Protection and Coord. of Industrial and Commercial Power Systems (IEEE Buff Book).
5. IEEE 399, Analysis (IEEE Brown Book), Recommended Practice for Power System Analysis.
6. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations.
7. NFPA 70E, Electrical Safety in the Workplace.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Professional Engineer:
 - a. Engage a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated. Professional engineer may be employed by independent consulting firm or manufacturer of power distribution equipment.

- b. Professional engineer shall have not less than five years of experience performing electrical power distribution system studies similar in scope and size to the studies required for the Project.
 - c. Submit qualifications data.
 - d. Responsibilities include but are not necessarily limited to:
 - 1) Performing or supervising the performance of electrical power distribution system studies and related field services.
 - 2) Preparing or supervising the preparation of test plans and test reports, and interpretation and engineering analysis of test data. Test reports shall bear the seal and signature of the professional engineer. State of licensure, license number, and professional engineer's name shall be clearly legible on the seal.
 - 3) Certifying that tests performed and results achieved conform to the Contract Documents.
 - 2. Field Engineer:
 - a. Field engineer performing protective device testing shall be experienced in type of testing required and testing equipment used on the Project.
 - b. Field engineer may be an employee of the protective device equipment manufacturer.
- B. Test equipment and instrument calibration shall comply with accuracy standards of NIST and ANSI/NCSL Z540.3.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
- 1. Studies:
 - a. Calculations and results of the short-circuit study, protective device evaluation, and coordination studies in report format. Report shall be sealed and signed by the professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
 - b. Time current curves for protective devices included within the power system studies.
 - c. Calculations and results of arc-flash analysis in report format sealed and signed by professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
 - 2. Testing Plan: Submit work plan for field testing. Submit and obtain ENGINEER's approval prior to performing tests. Plan shall indicate schedule of field testing, time frames for tests, and duration of equipment outage for testing. Submit shutdown requests for each outage in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
- B. Informational Submittals: Submit the following:
- 1. Test Reports:
 - a. Results of field testing.
 - 2. Qualifications Statements:
 - a. Professional engineer.
 - b. Field engineer, when required by ENGINEER.

- C. Closeout Submittals: Submit the following:
1. Final settings of protective devices. Submit compilation of final settings for each equipment lineup within 10 days of programming the associated protective devices.
 2. Electronic Files:
 - a. Protective Devices:
 - 1) Settings for all microprocessor-based protective devices.
 - 2) Software versions used to program the protective devices.
 - b. Electrical Power Distribution System Studies:
 - 1) Upon ENGINEER's approval or acceptance, as applicable, of submittals required under this Section, submit for OWNER's use all electronic files developed for the Work under this Section associated with the approved or accepted, as applicable, submittal to ENGINEER.
 - 2) Electronic files submitted for OWNER's use shall become OWNER's property.
 - 3) Source files for power studies performed under this Section.

1.5 ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

- A. General:
1. Perform a current and complete short-circuit study, protective device evaluation study, and protective device coordination study for the Site's electrical distribution system. Perform studies in accordance with IEEE 141, IEEE 242, and IEEE 399.
 2. Studies shall include all portions of high-, medium-, and low-voltage electrical power distribution systems, from the normal and alternate sources of power through low-voltage distribution system. Thoroughly cover in the study normal system operating method, alternate operation, and operations that could result in maximum fault conditions.
 3. Perform a complete study to evaluate both new and existing devices, and include recommendations on required adjustments. Studies shall include both the normal utility supply and standby generator systems.
 4. Promptly bring to attention of ENGINEER and OWNER problem areas and inadequacies in equipment.
 5. Perform both preliminary and final short-circuit and coordination studies. Preliminary study shall verify adequacy of equipment's short-circuit ratings and establish preliminary settings required prior for energizing equipment. Perform final short-circuit and coordination study and arc flash analysis after ENGINEER's acceptance of preliminary study, but not later than the date when equipment installed under the Project is placed into service. Study data shall include the following:
 - a. Preliminary Short-circuit and Coordination Study: Base the evaluation on the worst case operating mode. Base the evaluation on estimated cable lengths, and proposed equipment and protective devices.
 - b. Final Short-circuit and Coordination Study: Base the evaluation on utility-confirmed contribution. Evaluate the distribution system under each of the various operating modes. Base the evaluation on actual confirmed cable lengths, and installed equipment and protective devices.

B. Short-circuit Study:

1. Perform short-circuit evaluation using computer software specifically designed for such use.
2. Input data shall include electric utility company's short-circuit, single-, and three-phase contributions, with reactance/resistance (X/R) ratio, resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and other applicable circuit parameters.
3. Calculate short-circuit momentary duties and interrupting duties on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
4. Short-circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, total duty on the bus and individual contribution from each connected branch, including motor back electromotive force (EMF) current contributions, shall be listed with its associated X/R ratio.

C. Protective Device Evaluation Study:

1. Determine adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing short-circuit ratings of these devices with the available fault currents.
2. Apply appropriate multiplying factors based upon system X/R ratios and protective device rating standards.

D. Protective Device Coordination Study:

1. Perform study to select or to check selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
2. Overcurrent device settings estimated in the protective device coordination study shall provide complete, 100 percent selectivity. Selectively coordinate system such that only the device nearest a fault will operate to remove the faulted circuit. System selectively shall be based on both the magnitude and duration of a fault current.
3. Study shall include all voltage classes of equipment starting at electric utility's incoming line protective device, down to and including medium- and low-voltage equipment. Phase and ground overcurrent and phase and ground fault protection shall be included, and settings for other adjustable protective devices.
4. Plot time-current characteristics of installed protective devices on appropriate log-log paper. Maintain reasonable coordination intervals and separation of characteristic curves. Provide coordination plots for phase and ground protective devices for complete system. Use sufficient curves to clearly indicate selective coordination achieved through electric utility's main breaker, power distribution feeder breakers, and overcurrent devices at each major load center.
5. Show maximum of eight protective devices per plot. Appropriately title each plot and include the following information as required for the circuits shown:
 - a. Representative one-line diagram, legends, and types of protective devices selected.

- b. Power company's relays or fuse characteristics.
 - c. Significant motor starting characteristics.
 - d. Parameters of transformers, magnetizing inrush and withstand curves in accordance with ANSI C37.91.
 - e. Operating bands of low-voltage circuit breaker trip curves, and fuse curves.
 - f. Relay taps, time dial and instantaneous trip settings.
 - g. Cable damage curves.
 - h. Symmetrical and asymmetrical fault currents.
 - 6. Provide selection and settings of protective devices separately in tabular format listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Provide a tabulation of recommended power fuse selection for all fuses in system.
- E. Arc-Flash Analysis:
- 1. Conduct arc flash analysis after acceptance by ENGINEER of short-circuit study and coordination study. Perform arc flash analysis for each operating mode of the system, in accordance with IEEE 1584 and NFPA 70E.
 - 2. Document the protection and calculation procedures and coordination review in testing report. Present analysis results in tabular format showing the following:
 - a. Bus and protection device name.
 - b. Bolted and arcing fault values.
 - c. Protective device trip times.
 - d. Arc flash boundary, working distance, and incident energy.
 - e. Required protective flame-resistant (FR) clothing class.

1.6 STUDY REPORT

- A. Summarize results of electrical power distribution system studies in a typed or computer-printed report that includes the following:
 - 1. Description, purpose, basis, written scope, and single-line diagram of power distribution systems evaluated.
 - 2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties. Evaluation of short-circuit calculations and identification of underrated equipment.
 - 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, and fuse selection. Include an evaluation and discussion of logical compromises for proposed protection.
 - 4. Fault current tabulation including definition of terms and guide for interpretation.
 - 5. Tabulation of appropriate tap settings for relay seal-in units.
 - 6. Tabulation of equipment survey information.
- B. Electrical power distribution system studies report shall include a separate section addressing arc flash analysis. In addition to protection and calculation procedures, and coordination review and analysis results, report shall include protective device evaluation for each high-incident energy case to determine if adjustments can improve system performance relative to arc flash hazard level.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 TEST AND EVALUATION FIRM (NOT USED)

3.2 PREPARATION

A. General:

1. Coordinate with professional engineer performing the studies and assist professional engineer with collecting information necessary to complete the specified studies.
2. Prior to performing studies, obtain information pertaining to existing system necessary for performing studies.

3.3 FIELD SERVICES

- A. CONTRACTOR's professional engineer shall conduct an equipment survey and data gathering of existing devices and information necessary to perform electrical power distribution system studies.
- B. To the extent applicable, perform survey that includes the following information:
1. Manufacturer, type, and size of each power fuse.
 2. Manufacturer, type, model, and settings for each protective relay, trip unit, and circuit breaker.
 3. Current transformer ratios for each protective relay.
 4. Appropriate data for motors and transformers included with the study.
- C. CONTRACTOR's professional engineer shall confirm and establish proper settings for protective devices. Professional engineer shall collect data and coordinate with equipment Suppliers to establish proper settings for the devices provided. Document in the study all devices and settings.

3.4 FIELD TESTING

A. Site Tests:

1. Provide protective device field testing in accordance with manufacturers' recommendations. Field testing shall be by CONTRACTOR's field engineer, after submittal of and ENGINEER's acceptance of electrical power distribution system studies. Field testing results shall be documented in a report that shall include final settings of protective devices.
2. Field engineer shall provide necessary tools and equipment and adjust, set, calibrate, and test protective devices. Protective relays and meters in medium- and low-voltage equipment shall be set, adjusted, calibrated, and tested in accordance with manufacturers' recommendations and the coordination study. Provide minor adjustments, repairs, and lubrication necessary for proper operation.
3. Electromechanical protective relays provided in accordance with the Contract Documents shall be set and tested for acceptance. Testing

shall include visual and mechanical inspection. Testing shall include overcurrent time and pick-up tests.

4. Solid state and multi-function trip devices shall be set, including required programming necessary for the protection required. Devices shall be checked, configured, and tested for setting and proper operation.

3.5 MAINTENANCE OF OPERATIONS

- A. Field testing may require that certain equipment be temporarily taken out of service. CONTRACTOR shall perform the Work with due regard to the need of OWNER for continuance of operations and in accordance with sequencing required in the Contract Documents. Submit testing procedures and schedules and obtain acceptance by ENGINEER prior to starting testing and related Work.

3.6 INSTALLATION

- A. Provide personnel protective equipment labels in accordance with Section 26 05 53, Identification for Electrical Systems.
 1. Supplier Services: Provide training for OWNER's operation and maintenance personnel in personnel protection equipment. Provide at least eight hours of training, in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

+ + END OF SECTION + +

SECTION 26 22 14

DRY-TYPE LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install dry type low-voltage distribution transformers.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 26, Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. NEMA ST-20, Dry Type Transformers for General Applications.
 - 2. NEMA TP-1, Guide for Determining Energy Efficiency for Distribution Transformers.
 - 3. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption for Distribution Transformers.
 - 4. UL 1561, Dry Type General Purpose and Power Transformers.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NEC Article 450, Transformers and Transformer Vault (Including Secondary Ties).

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Schedule of transformers to be furnished with ratings and other required technical data.
 - b. Proposed location for each transformer, including pad layout, dimensions, and appurtenances.
 - 2. Product Data:
 - a. Supplier's technical information for transformers proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Dry Type Two-Winding Transformer:

1. Type: Dry type, air cooled, low temperature rise. Transformers 15 kVA and larger shall be energy efficient, complying with NEMA TP-1 Class 1 efficiency levels. Transformers less than 15 kVA shall be general purpose.
2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as shown on the Drawings.
3. Insulation: Insulation and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA per the following table. Energy efficient transformers shall be capable of 15 percent continuous overload at 150 degrees C temperature rise.

kVA Rating	Insulation Class (degrees C)	Temperature Rise (degrees C)
1 to 15 kVA	185	115
25 to 500 kVA	220	115

4. Winding Taps, Transformers 15 kVA and Less: Two 5-percent below rated voltage, full capacity taps on primary winding.
5. Winding Taps, Transformers 25 kVA and Larger: Two 2-1/2-percent above rated voltage and four 2-1/2+ percent below rated voltage, full capacity taps on primary.
6. Basic impulse level shall be 10 kV.
7. Sound Level: NEMA ST-20 standard.
8. Enclosure: UL listed for the application.
9. Identification: Identify transformers in accordance with Section 26 05 53, Identification for Electrical Systems, with the transformer number and voltages, connection data, kVA ratings, impedance, and overload capacity.
10. Transformers shall comply with NEMA ST-20, NEMA TP-1, NEMA TP-2, and UL 1561.
11. Transformers shall bear the label of the Underwriters' Laboratories, Inc.

B. Non-Linear Load, K Factor Rated Transformer: (Not Used)

C. Dry Type Buck and Boost Transformer: (Not Used)

D. Dry Type Shielded Isolation Transformer: (Not Used)

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the conditions under which the dry type transformers are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on walls or floors at locations shown. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for convenient and safe operation and maintenance.

- B. Mount transformers so that vibrations are not transmitted to the building structural parts and other equipment. Make connections to transformers with flexible conduit.
- C. Adjust tap settings to provide proper voltage at panelboards.
- D. Install dry type transformers in conformance with governing codes and manufacturer's instructions and recommendations, and the Contract Documents.

+ + END OF SECTION + +

SECTION 26 24 16

PANELBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install panelboards.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. NEMA PB 1, Panelboards.
 - 2. UL 67, Panelboards.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of panelboards to be furnished with identification of their proposed location, and all electrical characteristics, including number and rating of branch circuit breakers and enclosure type.
 - 2. Product Data:
 - a. Manufacturer's technical information for panelboards proposed for use, including product literature and specifications. Indicate options and features to be provided.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements; Comply with the following:
 - 1. NEC Article 408, Switchboards and Panelboards.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Packing:
 - a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
 - b. Protect mating connections.
 - c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
 - 2. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work. Upon deliver, check materials and equipment for evidence of water that may have entered equipment during transit.

3. Comply with Section 01 65 00, Product Delivery Requirements.
- B. Storage and Protection:
1. Store panelboards in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
 2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Panelboards:
1. Manufacturers: Provide products of one of the following:
 - a. General Electric Company.
 - b. Eaton/Cutler-Hammer.
 - c. Schneider Electric/Square D Company.
 - d. Or equal.
 2. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles as shown or indicated on the Drawings.
 3. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown or indicated. Where indicated on the Drawings, circuit breakers shall be ground fault circuit interrupting type equipped with solid state sensing and five-milliamp sensitivity.
 4. Circuit breakers for 480-volt panelboards shall have minimum interrupting rating of 14,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Circuit breakers for other panelboards shall have minimum interrupting rating of 10,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings.
 5. Bus Bars: Bus bars shall be 98 percent conductivity copper. Four-wire panelboards shall have solid neutral bar. Each panel shall have ground bus bar.
 6. Main: Panelboards shall have main circuit breaker unless the Drawings specifically indicate main lugs only.
 7. Connect branch circuit breakers for sequence phasing.
 8. Enclosures: Panel enclosures shall be as required for the area classifications indicated in Section 26 05 05, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.
 9. Construction: Code-grade steel, ample gutter space, flush door, flush snap latch and lock. Panelboards shall comply with NEMA PB 1 and UL 67.
 10. Trim: Surface or flush as required.
 11. Directory: Typed or computer-printed card, with transparent protective cover in frame on back of door giving circuit numbers and area or equipment served.
 12. Identification: Identify panelboards in accordance with Section 26 05 53, Identification for Electrical Systems. Identification shall indicate panel number and voltage.
 13. Directory of Existing Panelboards: When adding or removing breakers or loads from existing panelboards, provide a new typed or computer-generated directory card, indicating the circuit numbers and equipment served.

- B. Integrated Panelboard and Transformer: (Not Used)

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Mounting: Install panelboards at locations shown or indicated. Set cabinets so that top branch circuit breaker is not over six feet above the floor.
- B. Directory: Complete typewritten or computer-printed directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.
- C. Arrange circuits to balance the loads on the panelboards.
- D. Identify panelboards in accordance with Section 26 05 53, Identification for Electrical Systems.
- E. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Verify proper installation prior to energizing panelboards.

+ + END OF SECTION + +

SECTION 26 27 26.13

LOW-VOLTAGE RECEPTACLES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install low-voltage receptacles.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.
 - 3. Section 26 05 33.36, Outlet Boxes.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 498, Standard for Attachment Plugs and Receptacles.
 - 2. UL 514D, Cover Plates for Flush-Mounted Wiring Devices.
 - 3. UL 943, Standard for Ground-Fault Circuit-Interrupters.
 - 4. UL 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
 - 5. UL 1449, Standard for Surge Protective Devices.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. Americans with Disabilities Act.
 - 2. NEC Article 406, Receptacles, Cord Connectors, and Attachment Plugs (Caps).

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data: Manufacturer's technical information for receptacles and cover plates proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Receptacles: (Not Used)
- B. Receptacles for Hazardous Locations: (Not Used)
- C. Ground Fault Interrupting Receptacles:
 - 1. Duplex grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, 125-volt AC, 20 amperes, gray color with ground fault circuit interrupting (GFCI) protection.

2. Ground fault interrupting receptacles shall comply with UL 943.
 3. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide weatherproof-while-in-use cover where shown on the Drawings as "WP" or "WPU", and provide where located in wet or corrosive location.
 4. Products and Manufacturers: Provide one of the following:
 - a. GFR5362SGY by Hubbell, Inc.
 - b. 2091-GRY by Pass & Seymour.
 - c. Or equal.
 5. Weather-resistant Ground Fault Interrupting Receptacles
 - a. Products and Manufacturers: Provide one of the following:
 - 1) 2095TRWRGRY by Pass & Seymour.
 - 2) Or equal.
- D. Surge Suppression Receptacles: (Not Used)
- E. Weatherproof Covers: (Not Used)
- F. Weatherproof-While-in-Use Covers:
1. Where receptacles are shown on the Drawings as "WP" or "WPU", and where receptacles are installed in wet locations as defined in area classification portion of Section 26 05 05, General Provisions for Electrical Systems, provide receptacles as specified in Paragraphs 2.1.A through 2.1.D of this Section, as applicable, with weatherproof-while-in-use covers as specified below.
 2. Provide covers that are UL-listed, weatherproof while receptacle is in use, and are of ultraviolet-resistant construction suitable for outdoor use in accordance with NEC 406.
 3. Material:
 - a. Non-metallic box with hinged, non-metallic cover.
 - b. Sealing gaskets between box and cover.
 - c. Stainless steel screws and hardware.
 - d. Color: Gray finish
 4. Products and Manufacturers: Provide one of the following:
 - a. TayMac Corporation.
 - b. Pass and Seymour Type WIU
 - c. Or equal.
- G. Power Receptacles: (Not Used)
- H. Power and Special Receptacles: (Not Used) receptacle.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Non-hazardous Locations: Install receptacles at locations shown, in outlet or device boxes in accordance with Section 26 05 33.36, Outlet Boxes.
- B. Hazardous Locations: Install receptacles in rigid metallic conduit systems.
- C. Install receptacles with ground pole in the down position.
- D. Mount receptacles 18 inches above finished floor in non-hazardous locations and 4.5 feet above finished floor in hazardous locations, unless otherwise shown or indicated in the Contract Documents.
- E. Install in conformance with Laws and Regulations.
- F. Identification:
 - 1. Identify each conductor with circuit number and lighting panel number in accordance with Section 26 05 53, Identification for Electrical Systems.
 - 2. Identify each receptacle with permanent phenolic tag. Tags shall include circuit number and lighting panel number.

+ + END OF SECTION + +

SECTION 26 27 26.23

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install snap switches for lighting and other systems.
- B. Related Sections:
 - 1. Section 26 05 53, Identification for Electrical Systems
 - 2. Section 26 05 33.36, Outlet Boxes.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. UL 20, General Use Snap Switches.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data: Manufacturer's technical information for switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Switches for Non-Hazardous Locations:
 - 1. Single pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1221-I, by Harvey Hubbel, Inc.
 - 2) Catalog No. 1991-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC1-I, by Pass & Seymour
 - 4) Or equal.
 - 2. Switches in non-hazardous areas shall be UL-listed in accordance with UL 20.
- B. Switches for Hazardous Locations:
 - 1. Material: Factory sealed tumbler switch suitable for installation in Class I, Group D hazardous locations. Cast gray iron alloy or cast malleable iron body and cover with zinc electroplate finish. Switch rated at 20 amperes, 120/277-volt AC.
 - 2. Switches in hazardous areas shall be UL-listed in accordance with UL 894.
 - 3. Products and Manufacturers: Provide one of the following:
 - a. Series EDS by Crouse-Hinds Company.
 - b. Type EDS by Appleton Electric Company.
 - c. Or equal.

C. Switch Covers:

1. Indoor covers shall be Type 304 stainless steel.
2. Outdoor, wet, or corrosive location covers shall be weatherproof and corrosion resistant.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switches at locations as shown or indicated in the Contract Documents in outlet or device boxes, in accordance with Section 26 05 33.36, Outlet Boxes.
- B. Mount wall switches 4.0 feet above finished floor, in accordance with the Americans with Disability Act, unless otherwise noted.
- C. Identify each conductor with circuit number and lighting panel number. Identification shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

+ + END OF SECTION + +

SECTION 26 28 16.33

DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install disconnect switches.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.
 - 3. Section 26 27 26.23, Snap Switches.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 98, Enclosed and Dead-Front Switches.
 - 2. NEMA KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 3. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NEC Article 404, Switches.
 - 2. Disconnect switches shall bear the UL label.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of each switch to be furnished, including location, rating, and NEMA enclosure type for each.
 - 2. Product Data:
 - a. Manufacturer's technical information for disconnect switches proposed for use.
- B. Maintenance Material Submittals: Submit the following:
 - 1. Extra Stock Materials:
 - a. Furnish one set of spare fuses for each fused disconnect switch to be installed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 - 1. Square-D Company.
 - 2. Cutler-Hammer.
 - 3. General Electric Company.

4. Siemens.
5. Or equal.

2.2 MATERIALS

- A. Service Disconnect Switches:
 1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in "OFF" position and safety handle.
 2. Rating: Voltage, current and short circuit ratings and number of poles as shown or indicated on the Drawings. Switch shall bear UL label indicating suitability for use as service equipment and shall comply with UL 98, NEMA KS 1, and NEMA 250.
 3. Provide auxiliary dry contacts to indicate switch position where shown on the Drawings.
- B. Single Throw, Circuit Disconnect Switches:
 1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick- make, quick-break mechanism, visible blades in the "OFF" position and safety handle.
 2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label and shall comply with the requirements of UL 98, NEMA KS 1 and NEMA 250.
 3. Provide auxiliary dry contacts to indicate switch position.
- C. Double Throw Safety Switches:
 1. Type: Unfused, double throw with center "OFF" position, quick-make, quick-break mechanism, visible blades in the "OFF" position, and safety handle.
 2. Rating: Voltage and current ratings and number of poles as required for circuits being disconnected. Switches shall bear UL label and shall comply with UL 98, NEMA KS 1, and NEMA 250.
 3. Provide auxiliary dry contacts to indicate switch position where shown on the Drawings.
- D. Disconnect Switches for 120-volt, Single-phase Circuits:
 1. Refer to Section 26 27 26.23, Snap Switches.
- E. Enclosures: NEMA rating shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
- F. Identification:
 1. Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems.
 2. Provide nameplate to identify the equipment served by disconnect switch and associated source of power.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work.

Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists. Mount disconnect enclosures at a height not exceeding six feet.
- C. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

+ + END OF SECTION + +

SECTION 26 29 33

CONTROL STATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install control stations, including pushbuttons, selector switches, and other control stations elements.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before control stations Work.
- C. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 29, Hangers and Supports for Electrical Systems.
 - 3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
 - 2. NEMA ICS 5, Industrial Control and Systems: Control-Circuits and Pilot Devices.
 - 3. NEMA ICS 6, Industrial Control and Systems Enclosures.
 - 4. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 5. UL 508, Industrial Control Equipment.

1.3 QUALITY ASSURANCE

- A. Component Supply and Compatibility:
 - 1. Obtain all control stations furnished under this Section from a single control station manufacturer.
 - 2. Components shall be suitable for the specified application and shall be integrated into the overall assembly by control station manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of control stations to be furnished with their location, rating, and NEMA enclosure type for each.
 - 2. Product Data:
 - a. Manufacturer's technical information and specifications for control stations proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Control Stations:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Cutler-Hammer.
 - b. General Electric Company.
 - c. Allen Bradley Company.
 - d. Square-D Company.
 - e. Or equal.
 - 2. Type: 30.5 mm industrial, heavy duty, oil-tight construction with clearly-marked legend plates.
 - 3. Emergency S top or Lockout Stop: Lockout stop pushbuttons shall be two-position, push-pull type with maintained contact and mushroom head. Provide control stations with padlocking attachment and legend plate reading "PUSH-TO-STOP, PULL-TO-START".
 - 4. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
 - 5. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position for maintained type and for spring return from left, right, or both left and right to maintained position.
 - 6. Control stations shall comply with NEMA ICS 2, NEMA ICS 5, and UL 508, and shall bear the UL label.
 - 7. Indicating Lights: 120 vac, push-to-test. Lens color shall be in accordance with Section 26 05 53, Identification for Electrical Systems.
 - 8. Enclosures: As required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems, and complying with NEMA 250 and NEMA ICS 6.
 - 9. Identification: Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems. Devices shall include front-mounted nameplates identifying function and equipment controlled, if not readily apparent.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install equipment as shown and indicated, and provide sufficient access and working space for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports where no wall or other surface exists, in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.

+ + END OF SECTION + +

SECTION 26 29 37

LOW-VOLTAGE COMBINATION MAGNETIC MOTOR STARTERS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install low-voltage combination magnetic motor starters.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.
 - 3. Section 26 29 33, Control Stations.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
 - 2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of low-voltage combination magnetic motor starters to be furnished, listing for each the installation location, NEMA rating and enclosure size, and equipment to be controlled.
 - b. Customized wiring diagrams for low-voltage combination magnetic motor starters.
 - 2. Product Data:
 - a. Manufacturer's technical information, specifications, and standardized wiring diagrams for low-voltage combination magnetic motor starters proposed.

PART 2 – PRODUCTS

2.1 EQUIPMENT

- A. Manufacturers: Provide products of one of the following:
 - 1. Square D Company.
 - 2. Allen Bradley Company.
 - 3. General Electric Company.
 - 4. Cutler-Hammer.
 - 5. Or equal.
- B. Design, fabricate, and test low-voltage combination magnetic motor starters in accordance with NEMA ICS 2 and NEMA 250.

C. General:

1. Type: Combination type with magnetic-only motor circuit protector with interrupting rating of not less than 65,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Magnetic coil operated, NEMA horsepower rated, with thermal overload protection. Coil shall be rated 120 vac.
2. Enclosures: Panel enclosures shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.
3. Functional Type: Full-voltage, single speed, non-reversing, unless otherwise shown or indicated on the Drawings.
4. Control power transformer fused and grounded on low-voltage (120 vac) side for each starter.
5. Auxiliary contacts for motor space heaters, remote status signals, and interlocks as shown or indicated on the Drawings and as required.
6. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with:
 - a. Thermal Overload Relays: Relays shall be thermal, bimetallic type, direct or current sensing. Relays shall include ambient compensation and be equipped with separate heater elements sized for full load amperes and service factor of actual motors furnished.
 - b. Each overload relay shall be manual-reset type and include provisions for resetting by an insulating button on front of starter unit door.
 - c. Overload relay shall include normally-open auxiliary contact for remote alarm purposes.
 - d. Size overload relay for full-load amperes and service factor of actual motors installed.
7. Pushbuttons, selector switches, pilot lights, and other devices shall be as shown on the Drawings and in accordance with Section 26 29 33, Control Stations.
8. Provide nameplate identifying equipment controlled in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:

1. Install equipment in accordance with the Contract Documents, Laws and Regulations, and manufacturer's installation instructions.
2. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
3. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide suitable 1/4-inch spacers so that enclosure is not installed directly against walls. Provide supports to rigidly support

equipment reasonably close to motor where no wall or surface capable of supporting equipment exists.

+ + END OF SECTION + +

SECTION 26 29 38

REDUCED VOLTAGE SOLID STATE MOTOR CONTROLLERS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install reduced voltage solid state (RVSS) motor controllers.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.
 - 3. Section 26 29 33, Control Stations.
- C. Definitions:
 - 1. The Reduced Voltage Solid State (RVSS) Motor Controller Unit shall refer to the actual controller unit that will be mounted within the specified enclosure.
 - 2. The Reduced Voltage Solid State (RVSS) Motor Controller System shall refer to the controller unit and all items specified under Controller System Options.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
 - 2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of RVSS motor controller systems to be furnished, listing for each the installation location, NEMA rating and enclosure size, and equipment to be controlled.
 - b. Customized wiring diagrams for RVSS motor controller system.
 - 2. Product Data:
 - a. Manufacturer's technical information, specifications, and standardized wiring diagrams for RVSS motor controller systems.

PART 2 – PRODUCTS

2.1 EQUIPMENT

- A. Manufacturers: Provide products of one of the following:
 - 1. SMC-50 Reduced Voltage Solid State Motor Controller as provided by Rockwell Automation Allen-Bradley.
 - 2. Or equal.

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Reduced Voltage, Solid State,
Motor Controllers
30036073

B. General:

1. Type: Combination type with standard circuit breaker with interrupting rating of not less than 65,000 ampere RMS symmetrical @480V, unless otherwise indicated on the Drawings. Magnetic coil operated, NEMA horsepower rated, with thermal overload protection. Coil shall be rated 120 vac.
2. Enclosures: Panel enclosures shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.
3. Functional Type: Reduced Voltage Solid-State Starter
 - a. General:
 - 1) Provide solid-state, step-less, current limiting, soft-start, motor controllers (RVSS) as shown or indicated on the Drawings.
 - 2) RVSS shall be three-phase type and shall include an overload relay and isolation contactor.
 - 3) Provide subsystems that will protect RVSS from damage due to over-current and over-voltage.
 - 4) Current Rating: 115 percent of motor nameplate rated current, continuous, minimum.
 - b. Required Features:
 - 1) Adjustable current limit of not more than 250 percent of motor nameplate full-load current throughout entire motor acceleration period including first three cycles of voltage waveform from instant start signal is engaged.
 - 2) Adjustable voltage acceleration, from two to 30 seconds.
 - 3) Adjustable voltage deceleration, from two to 30 seconds.
 - 4) Phase loss detection.
 - 5) LED diagnostic indicators.
 - 6) Static over-current and over-voltage trip.
 - 7) Phase reversal, line or fuse loss, and under-voltage protection.
 - 8) Power unit over temperature protection.
 - 9) Motor inverse time overload protection.
 - 10) Input line transient over-voltage protection.
 - c. Enclosure:
 - 1) Cooling fans, if required, shall incorporate anti-friction bearings and internal impedance type motor protection.
 - 2) If cooling fans are used, enclosure for that section shall be NEMA 12 FVF, or NEMA 12 EFVFF force ventilated with filters, in accordance with NEMA ICS 1-110, installed by motor control center manufacturer.
 - d. On start-up, start driven equipment at zero current and allow driven equipment to accelerate to maximum speed without exceeding the set current limit.
 - e. On normal shutdowns, ramp driven equipment down at set deceleration rate that is non-regenerative for motor prior to shutdown.
 - f. On emergency shutdowns, remove power to motor control circuit.
 - g. Diagnostic LEDs: Provide LEDs on unit front that indicate the

following:

- 1) Control power on.

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Reduced Voltage, Solid State,
Motor Controllers
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- 2) In Remote indication.
- 3) Motor Running.
- 4) System fault.
- 5) Winding Temp High.
- 6) Discharge Pressure High.
- 7) Leak Detected
- h. Control Outputs:
 - 1) Control output shall be electrically isolated, dry, normally open SPDT contacts, rated 10 amps at 120 vac.
 - 2) Provide the following control outputs:
 - i. Not in Remote
 - ii. Motor overload
 - iii. Motor running
 - iv. E-stop
 - v. Leak Detected
 - vi. Winding Temp high
 - vii. Discharge Pressure High
4. Control power transformer fused and grounded on low-voltage (120 vac) side for each starter.
5. Auxiliary contacts for motor space heaters, remote status signals, and interlocks as shown or indicated on the Drawings and as required.
6. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with:
 - a. Electronic Overload Relays: Relays shall be electronic type, multi-function, adjustable, current sensing type, that include overload, phase-unbalance, phase-loss, and equipment type ground fault in one package.
 - b. Each overload relay shall be manual-reset type and include provisions for resetting by an insulating button on front of starter unit door.
 - c. Overload relay shall include normally-open auxiliary contact for remote alarm purposes.
 - d. Size overload relay for full-load amperes and service factor of actual motors installed.
7. Pushbuttons, selector switches, pilot lights, and other devices shall be as shown on the Drawings and in accordance with Section 26 29 33, Control Stations.
8. Provide nameplate identifying equipment controlled in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:
 1. Install equipment in accordance with the Contract Documents, Laws and Regulations, and manufacturer's installation instructions.

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2. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
3. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide suitable 1/4-inch spacers so that enclosure is not installed directly against walls. Provide supports to rigidly support equipment reasonably close to motor where no wall or surface capable of supporting equipment exists.

+ + END OF SECTION + +

SECTION 26 41 13

LIGHTNING PROTECTION SYSTEM FOR STRUCTURES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals shown, specified, and required to furnish and install lightning protection systems for:
 - a. Home Depot Master Pump Station (MPS)
- B. Coordination:
 - 1. Review installation procedures included under other Sections and coordinate installation of items to be installed with or before lightning protection systems.
- C. Related Sections:
 - 1. Section 26 05 26, Grounding and Bonding for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. Lightning Protection Institute (LPI), LPI 175, Standard of Practice.
 - 2. LPI 176, Standard of Materials.
 - 3. NFPA 70, National Electrical Code.
 - 4. NFPA 780, Standard for the Installation of Lightning Protection Systems.
 - 5. UL 96A, Installation Requirements for Lightning Protection Systems.
 - 6. UL 651, Schedule 40 and 80 PVC Conduit.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Lightning Protection System Subcontractor:
 - a. Retain services of lightning protection Subcontractor regularly engaged in providing Master Labeled lightning protection systems.
 - 2. Subcontractor shall be LPI-certified Master Installer or Inspector.
 - 3. Subcontractor shall be listed with UL.
- B. Component Supply and Compatibility:
 - 1. Obtain all materials equipment included in this Section regardless of component manufacturer from a single lightning protection system manufacturer.
 - 2. Lightning protection system manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for specified service conditions and shall be integrated into the overall system by lightning protection system manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Complete scaled drawings showing proposed routing and layout of lightning protection system with installation details. Drawings shall include equipment connection details and download details.
 - 2. Product Data:
 - a. Manufacturer's catalog cuts and technical information.
 - b. Technical specifications.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certificates of LPI code compliance provided by manufacturer, together with UL Master Label certificate or letter of finding.
 - 2. Field Quality Control Submittals:
 - a. Master Installer or Inspector's final inspection report following installation.
 - 3. Qualifications Statements:
 - a. Lightning protection system Subcontractor.

1.5 GUARANTEE

- A. Guarantee:
 - 1. Lightning protection system shall be guaranteed by lightning protection system manufacturer against defective parts and installation for one year from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. System Description:
 - 1. Each lightning protection system shall consist of a complete cable network on the roof or top of structure involving all air terminals, splices, and bonds with cable downloads routed concealed either directly in the building construction or in conduit to ground, and ground rods all connected together in an appropriate manner and certified by LPI to provide a zone of protection to entire building against lightning strikes, in accordance with NFPA 780.
 - 2. Provide complete, certified lightning protection system. Provide bonding connections and miscellaneous items for complete system.

2.2 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 - 1. Heary Brothers Lightning Protection Company.
 - 2. Thompson Lightning Protection, Inc.
 - 3. Or equal.

2.3 MATERIALS

- A. General:
 - 1. Size materials in accordance with NFPA 780, UL 96A, and LPI 176.

2. Materials and equipment shall be labeled or listed by UL for use in Master Labeled lightning protection systems. Completed system shall conform to NFPA 70, NFPA 780, LPI 175, LPI 176, and UL96A.
 3. Materials shall comply in weight, size, and composition for class of structure to be protected in accordance with the following:
 - a. Use Class I materials for systems on structures not exceeding 75 feet in height.
 4. Materials shall be corrosion-resistant, heavy-duty type. Unless otherwise specified, materials shall be Type 316 stainless steel, copper, or high copper-content bronze castings. Bolts, screws, and hardware shall be Type 316 stainless steel.
 5. Use aluminum materials in locations where system components are mounted on aluminum surfaces to avoid electrolytic corrosion of dissimilar metals.
 6. Provide fittings, mounting bases, couplings, connectors, fasteners, and other system devices required for complete system.
- B. Ground Rods: Comply with Section 26 05 26, Grounding and Bonding for Electrical Systems.
- C. Ground Cables:
1. Ground cables shall be copper, except in connections to aluminum surfaces as required to prevent dissimilar metals reaction.
 2. Ground cable stranding, number and size shall be suitable for classification of structure to be protected.
 3. Exposed ground cable shall be corrosion resistant.
- D. Air Terminals:
1. Air terminals shall be stainless steel 5/8-inch diameter and minimum of 18 inches long.
 2. Air terminals shall include a cast bronze point protector, stainless steel adapter, and copper base.
- E. Non-Metallic Conduit and Fittings:
1. Non-metallic conduit shall be Schedule 80 PVC plastic, rated for 90 degrees C, conforming to UL 651.
 2. Non-metallic fittings shall be of same material and manufacturer as base conduit. Provide cement for joining fittings to conduit. Fittings shall be by same manufacturer as base conduit.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine the conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install main conductors to provide two-way path from each air terminal horizontally or downward to connections with ground terminals.

- B. Install conductors free of excessive splices and sharp bends. Conductor bends shall form an included angle of not less than 90 degrees and shall not have bend radius less than eight inches. Secure conductors to structure at intervals not exceeding three feet.
- C. Conceal down conductors where possible in exterior wall construction. Space down conductors at intervals averaging not more than 100 feet around perimeter of structure. Provide at least two down conductors for each protected structure.
- D. For structural steel frame construction, down conductors at upper and lower extremities and at intervals not exceeding 200 feet shall be connected to structural steel. Make connections to steel frame with bonding plates having eight square inches of contact, or by exothermic weld connections.
- E. Provide air terminals at intervals not exceeding 20 feet along ridges and around perimeter of flat or gently-sloping roofs. Air terminals shall project a minimum of 10 inches above the area protected.
- F. Protect flat or gently-sloping roofs exceeding 50 feet in width, by providing additional air terminals at intervals not exceeding 50 feet on flat or gently-sloping area. Locate air terminals within two feet of roof edges and outside corners of protected areas. Air terminal spacing exceeding these dimensions will be allowed if the area protected is within a "zone of protection" from lightning strikes.
- G. Provide air terminals for stacks, flues, mechanical equipment, and other objects, having metal thickness less than 3/16-inch and not located within a "zone of protection". Connect objects having metal thickness 3/16-inch or greater to lightning protection system.
- H. Do not connect copper equipment to aluminum surfaces, except using bimetal transition fitting. Lead coating is unacceptable for bimetal transition.
- I. Install roof penetrations using through-roof assemblies with solid bars and appropriate roof flashing. Conductors shall not pass directly through roof.
- J. Grounded metal bodies shall be bonded to the system using bonding connections and fittings. When ground conductors are installed in conduit, conduit shall be non-metallic.
- K. Bond building ground systems including electrical, communication, and telephone services and arresters.
- L. Bond metal pipes and roof mounted metal structure to the roof ground loop or to downlead cables.
- M. Provide ground electrodes for each down conductor dedicated for lightning protection system and bond electrodes to building or structure grounding system. Connect down conductor to ground rod using high-strength, removable ground clamp. Provide bronze ground rod clamp having at least 1.5 inches of contact between rod and conductor, measured parallel to the axis of the rod, at ground test wells.

3.3 FIELD QUALITY CONTROL

A. Inspection:

1. During installation, lightning protection system shall be inspected by Master Installer or Inspector at several stages during installation in accordance with LPI requirements.
2. Do not conceal system components until inspection has been completed and successfully inspected, and observed by ENGINEER.
3. Upon completion of lightning protection system, arrange for final lightning system inspection and submit final inspection report to ENGINEER. Final lightning system inspection shall be performed by Master Installer or Inspector in accordance with LPI requirements.

+ + END OF SECTION + +

SECTION 26 50 00

LIGHTING

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install lighting fixtures and associated controls.
- B. Coordination:
 - 1. Coordinate location of fixtures with piping, ductwork, openings, and other systems and equipment and locate clear of interferences.
 - 2. Coordinate fixtures to be mounted in hung ceilings with the ceiling suspension system proposed.
- C. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. Design Lights Consortium (DLC).
 - 2. LM-79-08 (or latest), IESNA Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products
 - 3. LM-80-08 (or latest), IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources
 - 4. NEMA SSL-1-2010 Electronic Drivers for LED Devices, Arrays or Systems.
 - 5. UL 1598, Safety of Luminaires.
 - 6. UL 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 410, Luminaires, Lamp holders, and Lamps.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Schedule of light fixtures to be furnished, indicating fixture type and location for each.
 - b. Customized wiring diagrams.
 - 2. Product Data:
 - a. Manufacturer's technical information, specifications, standard wiring diagrams, and catalog cuts for lighting fixtures proposed.
 - b. Fixture construction details.
 - c. ETL photometric and isocandle curves for each fixture proposed.

- d. Verification that recessed fixtures to be mounted in hung ceilings are compatible with ceiling suspension system proposed.
- B. Informational Submittals: Submit the following:
 - 1. Manufacturer's Instructions:
 - a. Instructions and recommendations for handling, storing, and protecting the equipment.
 - b. Installation instructions for the equipment, including setting drawings, templates, and directions and tolerances for installing anchorage devices.
- C. Maintenance Material Submittals: Submit the following:
 - 1. Spare Parts and Extra Stock Materials: Furnish spare parts for each type of unit required as indicated in Part 2 of this Section.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery:
 - 1. Upon delivery, inspect equipment for evidence of water that may have entered equipment during transit.
- B. Storage:
 - 1. Store lighting fixtures, controls, related materials, and equipment in clean, dry location with controls for uniform temperature and humidity. Protect materials and equipment with coverings and maintain environmental controls.
 - 2. Store materials and equipment for easy access for inspection and identification. Keep materials and equipment off ground, using pallets, platforms, or other supports. Protect materials and equipment from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Type: Lighting fixtures required shall be in accordance with the Lighting Fixture Schedule on the Drawings. Fixtures shall be complete with supports, ballasts, lamps, and incidentals, as required.
- B. Fixtures in hazardous locations shall be listed in accordance with UL 1598 and UL 844.
- C. LED Fixtures
 - 1. Diodes (Light Source)
 - a. LED diodes shall be acceptable for use in the luminaires that they were designed, tested and listed for.
 - b. Individual LED Diodes shall be designed such that failure of one LED will result in the loss of only the damaged LED. A loss of a single LED shall be isolated to prevent cascading failures.
 - c. The LED light source shall be comprised of LED modules connected to an integrated driver.
- D. Drivers

1. Driver shall be compatible with LED light sources with rated output voltage and maximum output power suitable to the LED's.
 2. Driver efficiency shall be greater than ninety percent at full load, at 25 degrees Celsius.
 3. Driver shall have an operating ambient temperature range suitable for operation in the ambient temperature typically found for the intended installation.
 4. Driver shall have a life expectancy consistent with the life expectancy of the LEDs.
- E. Fixtures located in area identified as hazardous in Section 26 05 05, General Provisions for Electrical Systems, shall each be approved as a complete assembly, shall be clearly marked to indicate maximum wattage of lamps for which they are approved, and be protected against physical damage by suitable guards.
- F. Hardware: Provide necessary hangers, supports, conduit adaptors, reducers, hooks, brackets, and other hardware required for safe fixture mounting. Hardware shall have protective, non-corrosive finish.
- G. Outdoor Fixtures: Provide each fixture to be installed outdoors with cut-off lens to reduce the fixture's light pollution emissions.
- H. Photocell:
1. Products and Manufacturers: Provide one of the following:
 - a. 2100 Series by Tork Time Controls, Inc.
 - b. Or equal.
 2. Cadmium sulfide hermetically-sealed cell, fully temperature compensated, with time delay of not less than 15 seconds to prevent false switching.
 3. Built-in fail safe light level selector, adjustable within limits of two to 50 foot-candles and factory set at 25 foot-candles.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:
1. Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision in the field where necessary to clear conflicts and obstructions.
 2. Mounting Heights: Mounting heights or elevations are to bottom of fixture or to centerline of device.
 3. Install fixtures in accordance with Laws and Regulations, the Contract Documents, and manufacturer instructions and recommendations.
 4. Mount fixtures so that sufficient access is available for ready and safe maintenance.

5. Securely fasten equipment to walls or other surfaces on which equipment is mounted.
- B. Boxes and Fixtures:
1. For units mounted against masonry or concrete walls, provide suitable 1/4-inch spacers to prevent mounting back of box directly against wall.
 2. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers, or Unistrut.
 3. Do not install boxes with open conduit holes.
 4. Cable each circuit and identify with tag.
- C. Mount photocells as shown and adjust foot-candle setting for proper dusk and dawn photo-control. Provide wiring in conduit from photocell to controls.

+ + END OF SECTION + +

SECTION 31 11 00

CLEARING AND GRUBBING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform clearing and grubbing as shown and specified in the Contract Documents.
2. The Work includes removing from the Site and disposing of trees, stumps, brush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material.
3. Pay all costs associated with transporting and disposing of debris resulting from clearing.
4. Limits of Clearing and Grubbing Work: Clear and grub all areas within the Work areas unless otherwise shown or indicated in the Contract Documents.

B. Related Sections:

1. Section 01 57 05, Temporary Controls.
2. Section 02 41 00, Demolition.
3. Section 32 01 91, Tree Protection and Trimming.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Arborist: Qualifications shall be in accordance with Section 32 01 91, Tree Protection and Trimming.

B. Regulatory Requirements:

1. CONTRACTOR shall comply with all laws, regulations, and permitting requirements applying to the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following

1. Shop Drawings:
 - a. Plan for removing trees and other large vegetation not explicitly shown or indicated for removal in the Contract Documents.
 - b. Plan showing proposed limits of clearing and grubbing, if different from clearing and grubbing limits shown or indicated in the Contract Documents.

B. Informational Submittals: Submit the following

1. Qualification Statements:
 - a. Arborist. Separate submittal is not required under this Section when arborist qualifications are submitted under Section 32 01 91, Tree Protection and Trimming.

1.5 WARRANTY

- A. CONTRACTOR shall warrant that Work performed under this Section will not permanently damage trees, shrubs, turf, and plants designated to remain, or other adjacent work, facilities, or property. If damage resulting from CONTRACTOR's operations becomes evident during the correction period, CONTRACTOR shall replace damaged items and property at no additional cost to OWNER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

- A. Protection:
 - 1. Throughout the Project, protect existing site improvements, including streets, drives, and Underground Facilities to remain (if any), and adjacent property and structures. Repair damage caused by CONTRACTOR to original condition or replace in kind, to satisfaction of ENGINEER, at no additional cost to OWNER.
 - 2. Protect trees, shrubs, vegetation, and grassed areas to remain by providing temporary fencing, barricades, wrapping, or other methods shown, specified, or accepted by ENGINEER. Correct at CONTRACTOR's expense damage caused by CONTRACTOR outside the limits of clearing Work.
 - 3. Do not remove trees without approval of ENGINEER, unless shown or indicated for removal.
 - 4. Do not locate construction equipment, stored materials, or stockpiles within drip line of trees and vegetation to remain.
- B. Site Preparation:
 - 1. Obtain, pay costs associated with, and comply with applicable permits required for clearing and grubbing Work.
 - 2. Delineation of Clearing and Grubbing Limits:
 - a. Locate and clearly flag trees and vegetation to remain, and other materials to remain in the clearing and grubbing limits. Locate and clearly flag salvable vegetation to be relocated.
 - b. Provide flagging to delineate limits of areas to be cleared or grubbed. Review at Site with ENGINEER before commencing removal of trees, vegetation, and other materials to be removed.
 - c. Replace flagging that is lost, removed, or destroyed, until clearing and grubbing Work is complete and ENGINEER allows removal of flagging.
 - 3. Erosion and Sediment Controls:
 - a. Provide applicable erosion and sediment controls before commencing clearing and grubbing Work.
 - b. Comply with erosion and sediment control requirements of Section 01 57 05, Temporary Controls.
 - c. Continue providing erosion and sediment controls as clearing and grubbing Work progresses to previously uncleared, ungrubbed areas of the Site.

3.2 CLEARING AND GRUBBING

- A. Remove and dispose of all trees, shrubs, stumps, roots, brush, logs, rubbish, and debris within limits of clearing and grubbing shown or indicated in the Contract Documents, unless otherwise shown or indicated.
- B. Trees and Shrubs Improperly Destroyed or Damaged:
 - 1. For each tree or shrub to remain that is destroyed or damaged beyond repair by CONTRACTOR, provide two replacements of the same species at locations to be designated by ENGINEER.
- C. Trees and shrubs to remain shall be protected, and trimmed where required, in accordance with Section 32 01 91, Tree Protection and Trimming.
- D. Salvable Vegetation:
 - 1. Trees, shrubs, and other vegetation requiring removal to facilitate the Work, and that will be transplanted elsewhere at the Site, shall be carefully balled and burlapped or placed in temporary pots, and stored at the Site in an acceptable area. Work involving removing and relocating trees, shrubs, and other vegetation shall be under the direction of qualified arborist acceptable to ENGINEER, or other professional acceptable to ENGINEER, hired by CONTRACTOR.
- E. Disposal of Cleared and Grubbed Materials:
 - 1. Dispose at appropriate off-Site location trees, stumps, rubbish, debris, and other cleared and grubbed material. Cleared or grubbed materials may remain at the Site only when allowed in the Contract Documents or when approved by ENGINEER in writing. Do not use cleared or grubbed material as fill, backfill, or in embankments.
 - 2. Dispose of cleared and grubbed material in accordance with Laws and Regulations.
 - 3. Do not burn clearing debris at the Site.

3.3 TOPSOIL REMOVAL

- A. Existing topsoil to be removed is defined as friable, clay loam, surface soil present in depth of at least four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material.
- B. Stripping:
 - 1. Strip topsoil to depths encountered, in manner that prevents intermingling of topsoil with underlying subsoil or other objectionable material. Remove heavy growths of grass and vegetation from areas before stripping.
 - 2. Do not strip topsoil from within drip line of each tree to remain as part of the completed Project.
- C. Stockpile topsoil in storage stockpiles in areas shown, or where otherwise accepted by ENGINEER. Construct storage piles so that surface water drains freely. Stabilize large topsoil piles with a cover crop and mulch, and provide silt fencing around perimeter of pile to prevent topsoil erosion and sedimentation; silt fencing shall be in accordance with Section 01 57 05, Temporary Controls. Cover smaller topsoil stockpiles, when used, with reinforced fabric to prevent windblown dust. Topsoil in excess of the quantity required for the finished Project shall remain property of OWNER.

+ + END OF SECTION + +

SECTION 31 23 05

EXCAVATION AND FILL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform all excavating, filling, and grading, and disposing of earth materials as shown, specified, and required for construction of structures, Underground Facilities, roads, and other facilities required to complete the Work.
2. Preparation of subgrade for slabs and pavements is included under this Section.
3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

B. Related Sections (NOT USED)

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ACI 522R, Pervious Concrete.
2. ANSI/AISC 360, Specification for Structural Steel for Buildings.
3. ASTM C29/C29M, Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
4. ASTM C33/C33M, Specification for Concrete Aggregates.
5. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
6. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
7. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
8. ASTM C150/C150M, Specification for Portland Cement.
9. ASTM C595/C595M, Specification for Blended Hydraulic Cements.
10. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
11. ASTM C989, Specification for Slag Cement for Use in Concrete and Mortars.
12. ASTM D422, Test Method for Particle-Size Analysis of Soils.
13. ASTM D448, Classification for Sizes of Aggregate for Road and Bridge Construction.
14. ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
15. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
16. ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
17. ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

18. ASTM D4253, Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
19. ASTM D4254, Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
20. ASTM D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
21. ASTM D4832, Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
22. ASTM D6023, Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
23. ASTM D6103, Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).
24. ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
25. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

1.3 TERMINOLOGY

- A. The following words or terms are not defined but, when used in this Section, have the following meaning:
 1. "Subgrade" is the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 1. Professional Engineer:
 - a. Engage a registered professional engineer legally qualified to practice in the same jurisdiction as the Site and experienced in providing engineering services of the kind indicated.
 - b. Responsibilities include but are not necessarily limited to:
 - 1) Reviewing system performance and requirements shown or indicated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance and requirements for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising the preparation of design calculations and related submittals verifying compliance of the system with the requirements of the Contract Documents.
 - 4) Signing and sealing all calculations, drawings, and submittals prepared by professional engineer.
 - 5) Certifying that:
 - a) it has performed the design of the system in accordance with the performance requirements stated in the Contract Documents, and
 - b) the said design conforms to Laws and Regulations, and to the prevailing standards of practice.
 2. CONTRACTOR's Testing Laboratory:
 - a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.

- b. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
- c. Testing laboratory shall be experienced in the types of testing required.
- d. Selection of testing laboratory is subject to ENGINEER's acceptance.

B. Quality Assurance Testing:

- 1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.
- 2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at OWNER's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
- 3. CONTRACTOR's Testing Laboratory Scope:
 - a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work with the Contract Documents.
 - b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
 - c. Submit to ENGINEER and CONTRACTOR written report results of each test.
- 4. Required Quality Assurance Material Testing by CONTRACTOR's Testing Laboratory:
 - a. Gradation in accordance with ASTM D422. Perform one test for every 1,000 cubic yards of each of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
 - b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials incorporated into the Work: general fill, and pipe bedding material.
 - c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 5,000 cubic yards of the following types of materials incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
 - d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
 - e. Requirement for trial batch may be waived by ENGINEER if sufficient field test data documenting compliance with specified material properties and performance properties is submitted to and accepted by ENGINEER. Tests shall have been made on concrete with identical mix design to mix design proposed for the Work, including sources of aggregate and manufacturers of cementitious materials and admixtures.

C. Regulatory Requirements:

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1. Perform excavation work in compliance with requirements of authorities having jurisdiction and Laws and Regulations, including:
 - a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).
2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Modifications to the Work proposed due to design of sheeting, shoring, bracing, cofferdams, and similar excavation supports.

B. Informational Submittals: Submit the following:

1. Procedure Submittals:
 - a. Excavation Plan: Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
 - 1) Name of CONTRACTOR's "competent person" in responsible charge of excavation and fill Work.
 - 2) Excavation method(s) and additional items to be included in the Work, as listed in Paragraph 1.5.B.2.a of this Section.
 - 3) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
 - 4) Copies of required permits and approvals, from authorities having jurisdiction and affected utility owners, for excavation methods proposed.
 - b. Proposed compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
2. Excavation Support Plan and Related Information Prepared by CONTRACTOR's Professional Engineer:
 - a. CONTRACTOR and CONTRACTOR's professional engineer shall prepare the following for submittal:
 - 1) Sheeting and bracing, or other protective system(s) required.
 - 2) Dewatering system.
 - b. Drawings shall be prepared by professional engineer qualified in the specialty involved. Do not submit calculations. ENGINEER's review and acceptance of submittal does not imply approval by ENGINEER of the associated Work. CONTRACTOR shall be solely responsible for designing, installing, operating and maintaining the system(s) necessary to satisfactorily perform all sheeting, bracing, protection, underpinning, and dewatering.
3. Delivery Tickets:
 - a. Copy of delivery ticket for each load of aggregate and borrow material delivered to the Site. Each delivery ticket shall indicate project and contract by name and number, date, material type, department of transportation item number when applicable, and quantity delivered.

4. Quality Assurance Test Results Submittals:
 - a. Submit results of quality assurance testing performed by in accordance with Paragraph 1.4.B of this Section, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
 - 1) Tests on borrow fill material.
 - 2) Optimum moisture – maximum dry density curve for each type of fill material.
5. Field Quality Control Submittals:
 - a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
 - 1) Field density testing.
6. Qualifications Statements:
 - a. Professional engineer.

1.6 SITE CONDITIONS

- A. Soil borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER. Coordinate CONTRACTOR-performed test borings and other exploratory operations with OWNER and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of OWNER or utility owners. Comply with Laws and Regulations relative to required notifications.
- B. Existing Structures:
 1. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. CONTRACTOR shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by CONTRACTOR. Immediately repair and restore existing structures and Underground Facilities damaged by CONTRACTOR without additional cost to OWNER.
 2. Movement or operation of construction equipment over Underground Facilities shall be at CONTRACTOR's sole risk and only after CONTRACTOR has prepared and submitted to ENGINEER and utility owners (as applicable), and received acceptance therefrom, a plan describing CONTRACTOR's analysis of the loads to be imparted and CONTRACTOR's proposed measures to protect structures and Underground Facilities during the Project.
 3. Coordinate with utility owners for shut-off of services in active piping and conduits. When required by utility owner, OWNER will assist CONTRACTOR with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
 4. In general, service lines and laterals to individual houses and businesses are not shown; however, CONTRACTOR shall assume that a service exists for each utility owner to each house, business, and property.
 5. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by ENGINEER after

acceptable temporary utility services are provided by CONTRACTOR for the affected structure or property.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Select Fill:

1. Material shall be well-graded, crushed aggregate, free of organic material, complying with the following:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
1.25-inch	100
No. 4	38 to 65
No. 8	25 to 60
No. 30	10 to 40
No. 200	3 to 12

B. General Fill:

1. Material shall be free of: rock and gravel larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious matter.
2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
3. Previously-excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
4. When on-Site materials are found unsuitable for use as general fill, provide select fill or approved off-Site general fill materials. Prior to using off-Site material as general fill, furnish submittal for and obtain ENGINEER's approval of the material proposed for use.

C. Subbase Material:

1. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand, complying with the gradation requirements below.

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
2-inch	100
1-inch	70 to 100
3/4-inch	50 to 90
No. 4	30 to 60
No. 30	9 to 33
No. 200	0 to 15

D. Drainage Fill:

1. Material shall be washed, uniformly-graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1.5-inch sieve and not more than five percent passing a No. 4 sieve.

E. Pipe Bedding Material:

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1. Aggregate material shall be crushed stone and gravel, free of: rock or gravel larger than one-inch in any dimension, debris, waste, frozen materials, organic material and other deleterious matter. Material shall comply with gradation requirements below:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
1-inch	100
3/8-inch	30 to 65
No. 4	25 to 55
No. 10	15 to 40
No. 40	8 to 20
No. 200	2 to 8

2. Sand material, where required, shall consist of natural or manufactured granular material and shall contain no organic material. Sand shall be non-plastic, when tested in accordance with ASTM D4318, 100 percent shall pass a 1/2-inch screen and not more than five percent shall pass a No. 200 screen.

F. Mudmat:

1. Mudmat shall be in accordance with Section 03 30 00, Cast-in-Place Concrete.

2.2 SOURCE QUALITY CONTROL

- A. Perform quality assurance testing, and submit results to ENGINEER, in accordance with the 'Quality Assurance' Article in Part 1 of this Section.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Provide ENGINEER with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. ENGINEER will advise CONTRACTOR in writing when ENGINEER is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 TEST PITS

A. General:

1. In advance of the construction, excavate, make observations and measurements, and fill test pits to determine conditions or location of the existing Underground Facilities and structures. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for test pits. CONTRACTOR shall be responsible for the definite location of each existing Underground Facility involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting the affected Underground Facility or structure.

CONTRACTOR shall be responsible for repairing, at his expense, damage to Underground Facility or structure caused during the Work.

B. Payment for Test Pits:

1. All payment for test pits shown or indicated in the Contract Documents will be part of the lump sum Contract Price.
2. Payment for test pits required by ENGINEER and not shown or indicated in the Contract Documents will be paid as Unit Price Work.
3. Separate payment will not be made for test pits made by CONTRACTOR for CONTRACTOR's own use.

3.3 PREPARATION

A. Use of Explosives:

1. Use of explosives is not allowed.

B. Dust Control:

1. Control objectionable dust caused by CONTRACTOR's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to ENGINEER's acceptance and approval of authorities having jurisdiction.

D. Maintenance and Protection of Traffic:

1. Keep all streets and traffic ways open for passage of traffic and pedestrians during the Project, unless otherwise approved by owner of the street, traffic way, or right-of-way, as applicable.
2. When required to cross, obstruct, or temporarily close a street or traffic way, provide and maintain suitable bridges, detours, and other acceptable temporary expedients to accommodate traffic. Closings of street or traffic way shall be for shortest time practical, and passage shall be restored immediately after completion of fill and temporary paving or bridging.
3. Give required advance notice to fire department, police department, and other emergency services as applicable of proposed construction operations.
4. Give reasonable notice to owners or tenants of private property who may be affected by construction operations. Give such notice not less than 45 days prior to construction that will affect the property.
5. Hydrants, valves, fire alarm boxes, postal boxes and delivery service boxes, and other facilities that may require access during construction shall be kept accessible for use.
6. Provide temporary signage, signals, barricades, flares, lights and other equipment, service, and personnel required to regulate and protect traffic and warn of hazards. Such Work shall comply with requirements of owner of right-of-way and authorities having jurisdiction at the Site. Remove temporary equipment and facilities when no longer required, and restore grounds to original or to specified conditions, as applicable.

3.4 DEWATERING

A. Dewatering – General:

1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering

excavations, or other parts of the Work and work areas. Keep each excavation dry during excavation, subgrade preparation, and continually thereafter until the structure to be built therein is acceptable to ENGINEER and backfilling operations are completed and acceptable to ENGINEER.

2. Keep all working areas at the Site free of surface water at all times. Provide temporary drainage ditches and temporary dikes, and provide required temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.
3. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
4. CONTRACTOR shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.
5. Remove water from excavations as fast as water collects.

B. Temporary Dewatering System:

1. CONTRACTOR shall design, provide, and operate dewatering system to include sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, and similar facilities, necessary to depress and maintain groundwater level 2 feet below the base of each excavation during all stages of construction operations.
2. Design and operate dewatering system to avoid settlement and damage to existing structures and Underground Facilities.
3. Groundwater table shall be lowered in advance of excavation for a sufficient period of time to allow dewatering of fine grain soils.
4. Maintain groundwater level at excavations two feet below lowest subgrade excavation until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural groundwater.
5. Operate dewatering system continuously, 24 hours per day, seven days per week. Provide standby pumping facilities and personnel to maintain the continued effectiveness of the system. Do not discontinue dewatering operations without first obtaining ENGINEER's acceptance for such discontinuation.
6. If, in ENGINEER's opinion, the water levels are not being lowered or maintained as required, provide additional or alternate temporary dewatering devices as necessary, at no additional cost to OWNER.
7. Locate elements of temporary dewatering system to allow continuous dewatering operation without interfering with the Work to the extent practicable.
8. Where portions of dewatering system are located in the area of permanent construction, submit to and obtain ENGINEER's acceptance of details of proposed methods of constructing the Work at such location. Control of ground water shall continue until the permanent construction

provides sufficient dead load to withstand hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until waterproofing Work is completed.

9. Perform pumping of water from excavations in a manner that prevents carrying away of unsolidified concrete materials, and that avoids damaging the subgrade.
 10. Before discontinuing dewatering operations or permanently allowing rise of groundwater level, prepare computations to demonstrate that structures affected by the water level rise are protected by fill or other means to sustain uplift. Use a safety factor of 1.25 when preparing such calculations.
- C. Disposal of Water Removed by Dewatering System:
1. CONTRACTOR's dewatering system shall discharge to a suitable location acceptable to OWNER, in accordance with Laws and Regulations.
 2. Convey water from excavations in closed conduits. Do not use trench excavations as temporary drainage ditches.
 3. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
 4. Dispose of water in manner that causes no inconvenience to OWNER, others involved in the Project, and adjacent and downstream properties.

3.5 EXCAVATION

- A. Perform all excavation required to complete the Work as shown, specified, and required. Excavations shall include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered or decomposed rock, pavements, rubbish, and other materials within the excavation limits.
- B. Excavation Protection:
1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
 2. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
 3. Excavations Greater Than Five Feet Deep: Excavations in stable rock may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
 4. Provide and maintain excavation protection system(s) in accordance with submittals accepted by ENGINEER and required under Paragraph 1.5.B of this Section.
- C. Maintain excavations in dry condition in accordance with "Dewatering" Article in Part 3 of this Section.
- D. Elevation of bottom of footings shown is approximate. ENGINEER may direct such minor changes in dimensions and elevations as may be required to secure a satisfactory footing.

- E. When excavations are made below required grades without written order of ENGINEER, fill such excavations with compacted select fill material, as directed by ENGINEER, at CONTRACTOR's expense.
- F. Extend excavations sufficiently on each side of structures, footings, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.
- G. Subgrades – General:
 - 1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with Subbase material. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
 - 2. If, in ENGINEER's opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within CONTRACTOR's control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at CONTRACTOR's expense.
- H. Proofrolling Subgrades:
 - 1. Prior to placing fill or constructing pavements or slabs, proofroll the subgrade surface with sufficient proofrolling apparatus. Before starting proofrolling, submit to and obtain acceptance from ENGINEER of proofrolling apparatus and procedure to be used.
 - 2. Proofrolling operations shall be made in the presence of ENGINEER. Notify ENGINEER at least 24 hours in advance of start of proofrolling operations.
 - 3. Subgrades displaying pronounced elasticity or deformation, deflection, cracking, or rutting shall be stabilized as directed by ENGINEER. Unsuitable materials shall be undercut to the depth directed by ENGINEER and replaced with select fill material. Other suitable stabilization methods may be directed by ENGINEER.
- I. Pipe Trench Preparation:
 - 1. Not more than 150 feet of trench may be opened in advance of installing pipe in trench.
 - 2. Trench width shall be minimized to greatest extent practical, and shall comply with the following:
 - a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping. Refer to Drawings for trench requirements. In no case should trench be wider at top of pipe than pipe barrel OD plus two feet, unless otherwise shown or indicated.
 - b. Enlargement of trench width at pipe joints may be made when required and approved by ENGINEER.
 - c. Trench width shall be sufficient for shoring and bracing, or shielding and dewatering.
 - d. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.

- e. Do not use excavating equipment that requires the trench to be excavated to excessive width.
- 3. Depth of trench shall be as shown or indicated. If required and approved by ENGINEER in writing, depths may be revised.
- 4. Where ENGINEER considers existing material beneath bedding material unsuitable, remove and replace such unsuitable material with select fill material.
- J. Excavated Materials to be Used as Fill:
 - 1. Stockpile excavated materials that are acceptable for use as fill.
 - 2. As excavation proceeds, keep stockpiles of excavated materials suitable for use as fill separate from unsuitable materials and waste materials.
 - 3. Place, grade, and shape stockpiles for proper drainage.
 - 4. Locate and retain soil materials away from edge of excavations.
 - 5. Dispose of excess soil material and waste materials as specified in this Section.
 - 6. Stockpiled excavated soils for use as select fill or general fill shall be tested and classified by laboratory as on-Site select fill or on-Site general fill. Perform required quality assurance testing for material verification on stockpiled materials as soon as possible to demonstrate compliance of excavated materials with the Contract Documents.

3.6 UNAUTHORIZED EXCAVATION

- A. All excavations outside lines and grades shown or indicated and that are not approved by ENGINEER, together with removing and disposing of the associated material, shall be at CONTRACTOR's expense. Fill unauthorized excavations with properly-compacted select fill material at CONTRACTOR's expense.

3.7 EROSION AND SEDIMENT CONTROLS

- A. Provide temporary erosion and sediment controls in accordance with Section 01 57 05, Temporary Controls. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction.

3.8 SHEETING, SHORING, AND BRACING

- A. General:
 - 1. Design and provide sheeting, shoring, bracing, cofferdams, and similar excavation supports as shown, specified, and required for the Work.
 - 2. Clearances and types of temporary sheeting, shoring, bracing, and similar excavation supports, insofar as they may affect the finished character of the Work and the design of sheeting to be left in place, will be subject to the ENGINEER's approval; but CONTRACTOR is responsible for adequacy of all sheeting, shoring, bracing, cofferdams, and similar excavation supports.
 - 3. Materials:
 - a. Previously-used materials shall be in good condition, and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.

- b. All steel work for sheeting, shoring, bracing, cofferdams and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
 - 4. As excavation progresses, carry down shoring, bracing, cofferdams, and similar excavation supports to required elevation at bottom of excavation.
 - 5. Comply with Laws and Regulations regarding sheeting, shoring, bracing, cofferdams, and similar excavation supports.
 - 6. Maintain sheeting, shoring, bracing, bracing, and other excavation supports in excavations regardless of time period excavations will be open.
 - 7. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and Underground Facility, their appearance, and adjacent construction.
- B. Removal of Sheeting and Bracing:
- 1. Remove sheeting and bracing from excavations, unless otherwise directed by ENGINEER in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and Underground Facilities.
 - 2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
 - a. Concrete has cured for not less than seven days.
 - b. Wall and floor framing, up to and including grade level floors, is in place.

3.9 TRENCH SHIELDS

- A. Excavation of earth material below bottom of trench shield shall not exceed the limits established in Laws and Regulations.
- B. When using a shield for installing piping:
 - 1. Portions of trench shield extending below the mid-diameter of an installed, rigid pipe, such as prestressed concrete pipe and other types of rigid pipe, shall be raised above the pipe's mid-diameter elevation prior to moving the shield along the trench for further construction.
 - 2. Bottom of shield shall not at any time extend below mid-diameter of installed pipe that is flexible or has flexing capability, such as steel, ductile iron, PVC, CPVC, polyethylene, and other pipe that has flexing capability.
- C. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.
- D. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other Underground Facilities, and prevent disturbance of bedding material for piping, structures, and other Underground Facilities. When piping, structures, or Underground Facilities are disturbed, remove and reinstall the disturbed items in accordance with the Contract Documents.

3.10 FILL AND COMPACTION – GENERAL PROVISIONS

- A. Provide and compact all fill required for the finished grades as shown and as specified in this Section.
- B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
 - 1. ENGINEER's authorization after observation of construction below finish grade, including dampproofing, waterproofing, perimeter insulation, and similar Work.
 - 2. Inspection, testing, approval, and recording of locations of Underground Facilities.
 - 3. Removal of concrete formwork.
 - 4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
 - 5. Removal of trash and debris.
 - 6. Permanent or temporary horizontal bracing is in place on horizontally-supported walls.
- C. Fill that includes organic materials or other unacceptable material shall be removed and replaced with approved fill material in accordance with the Contract Documents.
- D. Placement – General:
 - 1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and Underground Facilities.
 - 2. Fill areas shall be undercut and proof-rolled as directed by ENGINEER.
 - 3. Place fill materials at moisture content and density as specified in Table 31 23 05-A of this Section and this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of discing, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.
 - 4. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required in the Contract Documents. Use light compaction equipment, with equipment gross weight not exceeding 7,000 pounds within horizontal distance of ten feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and Underground Facilities. Effectiveness of the equipment selected by CONTRACTOR shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one

or more of the following: increase the amount of coverages, decrease the lift thicknesses, or use different compactor equipment.

5. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
6. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
7. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment, CONTRACTOR shall perform all work required to provide the required densities. Such work shall include, at no additional cost to OWNER, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
8. Repair, at CONTRACTOR's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by ENGINEER.

E. Fill Against Concrete:

1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 30 00, Cast-in-Place Concrete.
2. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
3. Backfill structural foundation units as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
4. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

F. Fill in Electrical Ductbank Trenches:

1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
2. Placing and compacting fill in electrical ductbank trenches shall comply with requirements of Paragraph "G. Fill in Pipe Trenches", of this Article.

G. Fill in Pipe Trenches:

1. Place pipe bedding material in pipe trenches in horizontal layers, and thoroughly compact each layer before the next layer is placed.
2. Piping Installed in Fills Above Pre-construction Grade:

- a. Prior to installing piping, place the fill in accordance with the Contract Documents until the fill reaches a minimum elevation two feet higher than the top of piping to be installed. Excavate the trench; install the piping, and backfill. Subsequently provide the remainder of the fill required for the Work.
3. Piping trenches may be backfilled prior to testing of piping, unless nature of the test requires observation of pipe during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.
4. Pipe Bedding: Pipe bedding material shall be as follows:
 - a. Install PVC, CPVC, HDPE, and FRP piping on a layer of sand. Sand shall extend to 12 inches above top of pipe and to the trenchwalls on each side of the pipe.
 - b. Unless otherwise shown, install other types of piping on not less than six-inch layer of aggregate pipe bedding material. Aggregate pipe bedding material shall extend 12 inches above top of the pipe.
5. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placement and compaction of pipe trench fill materials shall comply with the following:
 - a. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
 - b. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and around each side of the pipe and back of the bell or end thereof to hold piping in proper position and maintain alignment during subsequent pipe jointing and embedment operations. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping. Place and compact pipe trench fill material to an elevation 12 inches above top of pipe, unless otherwise shown or specified.
 - c. Each layer of pipe trench fill material shall be compacted by at least two complete coverages of all portions of surface of each lift using appropriate compaction equipment.
 - d. Method of compaction and compaction equipment used shall be appropriate for material to be compacted and shall not transmit damaging shocks to the piping.

H. Temporary Pavement:

1. Place 1.5 inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
2. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
3. Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.

I. Subbase Placement:

1. Provide subbase material where shown to the limits shown or indicated.
 2. Place subbase material in compacted lifts not exceeding depth of six inches each.
- J. Drainage Fill Placement:
1. Provide drainage fill material where shown to the limits shown or indicated.
 2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of six inches each. Compact lifts of drainage fill using suitable compaction equipment.
- K. Compaction Density Requirements:
1. Compaction required for all types of fills shall be in accordance with Table 31 23 05-A of this Section. Moisten material or aerate the material as necessary to provide the moisture content that will facilitate obtaining the required compaction.

**TABLE 31 23 05-A
REQUIRED MINIMUM DENSITY**

Material	Percent Compaction (ASTM D698)	Uncompacted Lift (inches)
General Fill		
More than five feet below final grade	100	8
Less than five feet below final grade	95	8
Select Fill		
Below concrete slabs or mats	100	8
Below pavement and sidewalks	100	12
Behind concrete walls	95	8
Subbase Material		
Below pavement and sidewalks	100	12
All other locations	100	8
Pipe Bedding Material		
Below structures or pavement	100	8
All other locations	95	6
Drainage Fill	N/A	6

2. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus three percent, with the following exceptions:
 - a. On-site clayey soils: Optimum to plus three percent.
3. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated in Table 31 23 05-A of this Section.
4. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the "Field Quality Control" Article in Part 3 of this Section.

5. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to OWNER until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by ENGINEER) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.
- L. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with Table 31 23 05-A and the associated "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location.

3.11 GRADING

- A. General:
 1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
 2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
- B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:
 1. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.
 2. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below the required subgrade elevation.
 3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.
- C. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten foot straight edge.
- D. Compaction:
 1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 CONTROLLED LOW STRENGTH MATERIAL (CLSM) (NOT USED)

3.13 PERVIOUS CONCRETE (NOT USED)

3.14 PAVEMENT SUBBASE COURSE

- A. General:
 - 1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
 - 2. After completing filling and grading, shape and compact pavement subgrade to an even, firm foundation in accordance with this Section. Remove unsuitable subgrade materials, including soft materials, boulders, vegetation, and loose stones, and replace with compacted fill material as directed by ENGINEER.
- B. Grade Control:
 - 1. During construction, maintain lines and grades including crown and cross-slope of subbase course.
- C. Placing of Pavement Subbase Course:
 - 1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placing operations.
 - 2. Compaction and Grade Control: Comply with compaction requirements for excavation and fill in this Section, and the following requirements:
 - a. Compaction with roller shall begin at the sides of the area to be paved and continue toward the center. Continue compaction until there is no movement of the course ahead of the roller.
 - b. After compaction of top lift of pavement subbase, provide and uniformly spread pipe bedding material and screenings compacted, on the surface, and sweep using gang-dragged broom, followed by compaction.
 - c. After rolling, check for grade with a line not less than 40 feet in length; depression over 1/2-inch deep shall be filled to satisfaction of ENGINEER.
 - 3. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.
 - 4. Do not install pavement subbase in excess of 500 feet in length without compacting to prevent softening of the subgrade.
 - 5. If subgrade material becomes churned up into or mixed with the subbase material, remove the mixed material and replace with clean, compacted subbase material.

3.15 DISPOSAL OF EXCAVATED MATERIALS

- A. General:
 - 1. CONTRACTOR shall haul away material removed from excavations that does not comply with requirements for fill, or is in excess of the quantity required for fill.
 - 2. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to OWNER.

3.16 PRECONSOLIDATION (NOT USED)

3.17 PIEZOMETERS (NOT USED)

3.18 TEMPORARY BARRIERS

- A. Provide temporary barrier surrounding excavations and excavation work areas to provide temporary protection to persons and property. Barrier shall have openings only at vehicular, equipment, and worker access points.
- B. Minimum Material Requirements for Temporary Barriers:
 - 1. Temporary barrier shall not be less snow fence-type fencing, four feet high.
 - 2. Fence shall be constructed of vertical hardwood slats measuring not less than 1.5 inches by 1/4-inch interwoven with strands of horizontal wire, or shall be of equivalent plastic construction.
 - 3. Posts:
 - a. Posts shall be steel, either "U"-, "Y"-, "T"-shaped, or channel section.
 - b. Posts shall have a nominal weight of not less than 1/3-pound per linear foot, exclusive of the anchor.
 - c. Posts shall have tapered anchors weighing not less than 0.67 pounds, each firmly attached by means of welding, riveting or clamping.
 - d. Posts shall have corrugations, knobs, notches, or studs placed and constructed to engage a substantial number of fence line wire in the proper position.
 - e. Provide each post with sufficient quantity of galvanized wire fasteners or clamps, of not less than 0.120-inch diameter, for attaching fence wire to post.

3.19 SPECIAL PROCEDURES (NOT USED)

3.20 FIELD QUALITY CONTROL

- A. Site Tests: Employ a testing laboratory to perform field quality control testing.
 - 1. Testing Laboratory Scope:
 - a. Perform field moisture content and density tests to ensure that the specified compaction of fill materials has been obtained.
 - b. Tests of actual unconfined compressive strength or bearing tests on each stratum.
 - c. Report results of each test to ENGINEER and CONTRACTOR.
 - 2. Required Material Tests:
 - a. Compaction: Comply with ASTM D1556 and ASTM D6938, as applicable.
 - 3. Authority and Duties of Testing Laboratory:
 - a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings to ENGINEER and CONTRACTOR. When materials furnished or the Work performed does not comply with the Contract Documents, technician will direct attention of ENGINEER and CONTRACTOR to such failure.
 - b. Technician will not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered, nor shall it obligate ENGINEER for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax,

- enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.
4. Responsibilities and Duties of CONTRACTOR:
 - a. Use of testing laboratory shall in no way relieve CONTRACTOR of the responsibility to provide materials and Work in full compliance with the Contract Documents.
 - b. To facilitate testing laboratory, CONTRACTOR shall advise testing laboratory at least two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
 - c. It shall be CONTRACTOR's responsibility to accomplish the specified compaction for fill and other earthwork. CONTRACTOR shall control construction operations by confirmation tests to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the Contract Documents relative to compaction, control.
 - d. CONTRACTOR shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.
 - 1) 200 linear feet of trench fill.
 - 2) 10 cubic yards of select fill.
 - 3) 100 cubic yards of general fill.
 - 4) 50 cubic yards of subbase material.
 5. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be taken as follows:
 - a. Trenches for Structures, and Underground Facilities (including buried ductbanks):
 - 1) In Open Fields: Two locations every 1,000 linear feet.
 - 2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
 - 3) Crossing Paved Roads: Two locations along each crossing.
 - 4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
 - b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to ENGINEER.
 - c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.
 - d. For General Fill: One per 1,000 square feet on every compacted lift.
 - e. Subbase Material: One per 1,000 square feet on every compacted lift.
 6. Periodic compliance tests will be made by ENGINEER to verify that compaction is complying with the requirements specified, at no cost to CONTRACTOR. CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall fill and re-compact the excavation after testing is complete.

7. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, CONTRACTOR shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at CONTRACTOR's expense until subgrades, bedding, and fill are acceptable. Costs for retesting of subgrade, fills, or bedding materials that did not originally comply with specified density shall be paid by CONTRACTOR.

+ + END OF SECTION + +

SECTION 32 01 91

TREE PROTECTION AND TRIMMING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and perform tree protection and trimming.
2. Extent of plantings to remain are shown. Extent of tree protection and trimming may include, but is not limited to, crown cleaning, crown thinning, crown raising, crown reduction, vista pruning and crown restoration; in addition to soil aeration, trench cut supervision and hand tunneling; drip line, root zone and tree trunk protection, and temporary barriers.
3. Types of products required include the following:
 - a. Temporary protection barriers.
 - b. Tree wound dressing.
 - c. Drainage fill.
 - d. Topsoil.
 - e. Drain tile.
 - f. Straw.
 - g. Stone.
 - h. Burlap.
 - i. Accessories.

B. Coordination:

1. Review installation procedures under other Sections and coordinate construction activities and the installation of items that pass within the drip line, or that affect existing grade, in areas where existing plantings are to remain.

C. Related Sections:

1. Section 31 23 05, Excavation and Fill.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American National Standards Institute, (ANSI).
 - a. ANSI 300, Tree Care Operations - Tree, Shrub, and Other Woody Plant Maintenance - Standard Practices.
2. American Society for Testing and Materials, (ASTM).
 - a. ASTM C 700, Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
 - b. ASTM D 448, Classification for Sizes of Aggregate for Road and Bridge Construction.
3. International Society of Arboriculture, (ISA).
 - a. Trees and Building Sites.
 - b. Tree-Pruning Guidelines.

1.3 QUALITY ASSURANCE

- A. Professional Arborist Qualifications:
 - 1. Engage an accredited professional arborist, acceptable to ENGINEER, skilled, trained and with successful and documented experience in the protection and restorative care of trees, certified by the International Society of Arboriculture or American Society of Consulting Arborists; who agrees to employ only tradesmen with specific skill and successful experience in this type of Work.
 - 2. Submit names and qualifications to ENGINEER along with the following information on a minimum of three successful projects.
 - a. Names and telephone numbers of owner, architects or engineers responsible for projects.
 - b. Approximate contract cost of the tree protection and trimming.
 - c. Amount and kinds of tree protection and trimming performed.
- B. Tree Pruning Standards: Comply with ANSI A300 and ISA standards, unless more stringent requirements are specified, or required by Site conditions.
- C. Pre-installation Conference:
 - 1. Prior to commencement of Site construction Work, CONTRACTOR shall schedule and meet at the Site with professional arborist, installers of other Site construction Work in and around areas of existing plantings to remain, the ENGINEER and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to protection of existing plantings to remain, including the following:
 - a. Review Project requirements and the Contract Documents.
 - b. Review required submittals, both completed and yet to be completed.
 - c. Review availability of materials and methods of delivery.
 - d. Review location and types of below-grade work, required access during construction and methods of protection existing plantings.
 - e. Review Project Schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
 - f. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
 - g. Review procedures needed for protection of plantings during the remainder of the construction period.
 - h. Review required inspection, testing, and certifying procedures.
 - 2. Record the discussions of the conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
 - 3. Record all revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.
 - 4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Submit product data for each material specified.

- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certification by professional arborist that trees shown to remain were protected during the course of construction in accordance with recognized standards of the industry, as specified.
 - b. Certification that where damage did occur, trees were promptly and properly treated, or replaced.
 - 2. Qualifications Data:
 - a. Professional arborist.
- C. Closeout Submittals: Submit the following:
 - 1. Care and Maintenance Data:
 - a. Submit typewritten instructions recommending procedures to be established by OWNER for seasonal care and maintenance of trees affected by construction activities, after Substantial Completion.

1.5 PROJECT CONDITIONS

- A. Existing Conditions:
 - 1. A portion of the existing Site has been landscaped with exterior plants. Most of these in the immediate area of construction are shown. . Replace, in kind, to the satisfaction of ENGINEER, existing landscape plantings damaged as a result of Work performed under this Contract.
- B. Protection and Precautions:
 - 1. Protect existing trees to remain during the course of construction in accordance with recognized standards of the industry, as specified.
 - 2. Where damage occurs, professional arborist shall promptly and properly treat trees in accordance with recognized standards, as specified.
 - 3. Replace damaged trees, as specified, at no additional cost to the OWNER where, in the opinion of the professional arborist or ENGINEER, damaged trees are incapable of retaining full growth potential, or have been damaged to the extent that they can no longer perform their intended function in the landscape.

1.6 EXTENDED SERVICE

- A. Extended Landscape Service for Tree Repair and Replacement and Trees Affected by Grade Lowering:
 - 1. Begin extended service immediately after each tree is acceptably planted, or area regraded. Provide extended service for 90 days after tree plantings are acceptably completed and grade modifications performed.
 - 2. Prune, cultivate, water, weed, fertilize, shade, mist, restore planting saucers, tighten and repair stakes and guy supports, and reset tree plantings to proper grades or vertical position, as required to establish healthy, viable plantings.
 - a. Do not allow trees to wilt or show other signs of environmental stress. Visit the Site twice a week during the extended service periods, to inspect the condition of the plantings and immediately provide required care.
 - b. CONTRACTOR shall provide landscape installer who shall be available on-call if notified between regular visits that plants require critical care or maintenance, throughout the time of extended service period.

3. Check and observe tree plantings for signs of insect and disease attack. Take corrective measures immediately upon notice of such attack. Control damaging insects and diseases, as specified.
 4. Restore or replace damaged tree wrappings.
 5. Remove dead trees immediately. Replace immediately unless required to plant in the succeeding planting season.
- B. Provide sufficient water to ensure that tree root zone remains moist at all times.
1. Apply water using a 1-inch diameter hose with an attached metering gauge.
 2. Apply water at a sufficiently slow rate to prevent water run-off from the soil surface but great enough to provide 0.2-inches of water per square foot of canopy area per hour for five hours each week.
- C. Any decline in the condition of trees shall require CONTRACTOR to take immediate action to identify potential problems and undertake corrective measures. If required, engage professional arborist or horticulturist to inspect trees, identify problems and recommend corrective procedures. Advise ENGINEER of all such actions and submit inspection and recommendation reports.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Tree Wound Dressing: Provide tree wound dressing which is waterproof, adhesive and elastic with an antiseptic, free from kerosene, coal tar, creosote or any other material injurious to the life of the plant.
- B. Drainage Fill: Selected crushed stone, or crushed or uncrushed gravel, washed, ASTM D 448, Size 24, with 90 to 100 percent passing a 2-1/2-inch sieve and not more than ten percent passing a 3/4-inch sieve.
- C. Topsoil: Provide topsoil, as required, that is fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth, free of any admixture of subsoil, clods of hard earth, plants or roots, sticks or other extraneous material harmful to the growth of plants. Obtain topsoil only from well-drained sites where soil occurs in depth of 4-inches or more; do not obtain from bogs or marshes. Supply topsoil with the following analysis:
1. 3/4-inch Mesh: 100 percent passing.
 2. No. 4 Sieve: 90 to 100 percent passing.
 3. No. 200 Sieve: 0 to 10 percent passing.
 4. Clay content of material passing No. 200 sieve not greater than 60 percent, as determined by hydrometer tests.
 5. pH 5.0 to pH 6.5. If approved by ENGINEER, natural topsoil not having the hydrogen-ion value specified may be amended by CONTRACTOR at his own expense.
 6. Organic content not less than five percent, as determined by ignition loss.
 7. Free of pests or pest larvae.
- D. Drain Tile: Provide 4-inch standard strength, perforated bell-and- spigot clay pipe, in compliance with ASTM C 700.

- E. Filter Fabric: Manufacturer's standard, nonwoven, pervious, geotextile fabric of polypropylene, nylon, or polyester fibers.
- F. Stone: Naturally occurring at the Site, as selected by CONTRACTOR.
- G. Burlap: Jute not less than 7.2 ounces per square yard.

PART 3 - EXECUTION

3.1 PERFORMANCE

A. General:

1. Install temporary fencing, barricades or guards, located as recommended by professional arborist, outside the drip line of trees.
2. Protect tree root systems from damage caused by noxious materials from run-off or spillage during mixing, placing, or storing of construction materials. Protect root systems from flooding, erosion or excessive wetting resulting from dewatering operations or other construction activities.
3. Do not allow fires under or adjacent to trees or other plants to remain.
4. Do not store materials, debris, topsoil or excavated subsoil within the drip line of trees to remain. Do not permit vehicles within drip line. Restrict foot, vehicle and equipment traffic to prevent compaction of soil over root systems. Where such activities are unavoidable, and only as acceptable to ENGINEER, provide continuous heavy wood planking, effectively fastened together and capable of distributing all loads from such activities, above a filter fabric layer covered with 2-inches of gravel.
5. Cut branches and roots, if required, with sharp pruning instruments; do not break or chop. Paint cuts over 1/2-inch in size with tree wound dressing.

B. Excavation:

1. Excavate within drip line of trees only where shown.
2. Where trenching for utilities is required within drip line, tunnel under or around main lateral feeder roots by drilling, auger boring, pipe jacking, or digging by hand under supervision of professional arborist. Do not cut main lateral roots or tap roots; cut smaller roots, which interfere with installation of the Work.
3. Where excavation for construction is required within drip line of trees, hand excavate to minimize damage to root systems. Perform excavation under supervision of professional arborist. Install shoring or other protective support systems at excavations, to minimize sloping or benching of excavations. Use narrow tine spading forks and comb soil to expose roots.
4. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking. If encountered immediately adjacent to location of construction and relocation is not practical, cut roots approximately 3-inches back from construction.
5. Do not allow exposed roots to dry out before permanent backfill is placed; provide temporary earth cover. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.

C. Regrading:

1. Maintain existing grade within drip line of trees, unless otherwise shown or

specified.

2. Grade Lowering:

- a. Where new finish grade is shown below existing grade around trees, slope grade beyond drip line. Maintain existing grade within the drip line of trees.
- b. Prune tree roots exposed during grade lowering, or provide permanent protections as recommended by professional arborist. Do not cut main or lateral roots or taproots; cut only smaller roots.
- c. Compensate for loss of roots and prune branches to stimulate root growth.
- d. Provide extended service during the Contract period as recommended by professional arborist.

3. Minor Fills:

- a. Where existing grade is 6-inches or less below elevation of finish grade shown, fill with topsoil.
- b. Place in single layer and do not compact.
- c. Hand grade to required finish elevations.

4. Moderate Fills:

- a. Where existing grade is more than 6-inches, but less than 12-inches, below finish grade elevation, place a layer of drainage fill and filter fabric on existing grade prior to placing topsoil.
- b. Carefully place drainage fill against tree trunk approximately 2-inches above elevation of finish grade and extend not less than 18-inches from tree trunk on all sides.
- c. Place filter fabric with edges overlapping 6-inches, minimum.
- d. Place fill layer of topsoil to finish grade elevation.
- e. Do not compact stone, gravel or topsoil layers; hand grade to required finish elevations.

5. Deep Fills:

- a. Provide an open dry circular well of durable stone, without mortar, situated at least 24-inches from the tree trunk.
- b. To facilitate proper drainage, place eight to ten continuous runs of 4-inch drain tiles horizontally on the original grade under the complete spread of the branches in a radial pattern around the tree.
- c. Slope drains away from tree.
- d. Place drainage fill on the ground for a depth of 2-inches under and 6-inches over the drain tile.
- e. Place filter fabric over drainage fill.
- f. Place eight to ten 4-inch drain tiles vertically in a radial pattern around the tree at a distance of five feet from the tree. Extend vertical drain tiles from the filter fabric layer above the horizontal drain to finished grade.
- g. Hold drains in place with fill.
- h. Hand grade to required elevation.

D. Tree Pruning:

1. Remove branches from trees to remain only with the approval of ENGINEER, and only as required to clear permanent construction, using branch removal methods in compliance with specified standards.
2. Extend pruning operation to restore natural shape of entire tree where pruning is approved by ENGINEER.
3. Prune branches to balance loss to root system caused by damage or cutting of root system.

4. Chip branches removed from trees. Stockpile and spread chips as directed by the ENGINEER.
- E. Tree Repair and Replacement:
1. Cavity Repair:
 - a. Remove decayed areas to depth, which exposes healthy tissue.
 - b. Shape cavities to provide drainage.
 - c. Paint inside of cavity with accepted antiseptic tree wound paint.
 - d. Do not fill cavities.
 - e. When cavity cross section exceeds 60 percent of cross section of tree, remove tree upon authorization of ENGINEER.
 - f. Remove tree stumps to 12-inches below finished grade.
 2. Promptly repair trees damaged by construction operations within 24 hours of the occurrence of such damage. Treat damaged trunks, limbs, and roots according to written instructions of professional arborist.
 3. Remove and replace dead trees, and damaged trees determined by professional arborist to be incapable of restoration to normal growth pattern.
 4. If trees over 6-inches in caliper measurement, taken 12-inches above grade, are required to be replaced, provide new trees of 6-inch caliper size, and of the species selected by ENGINEER.
- F. Soil Aeration:
1. Aerate surface soil compacted during construction.
 2. Extend aeration operations from ten feet beyond the drip line of trees to an area no closer than three feet to tree trunk.
 3. Drill 2-inch diameter holes a minimum of 12-inches deep at two feet on centers.
 4. Fill holes with an equal mix of augered soil and sand.

3.2 CLEAN-UP

- A. Burning of removed trees, chips and branches is not permitted on the Site.
- B. Remove excess excavated material, displaced trees, excess chips and trimmings. Legally dispose off-Site.
- C. Remove protection barriers and load distributing layers when no longer needed and restore areas beneath trees.

+ + END OF SECTION + +

SECTION 32 12 00

FLEXIBLE PAVING

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install flexible, hot-mix, hot-laid, asphalt concrete pavement.
 - 2. The Work includes:
 - a. Preparation such as sawcutting, milling where shown or indicated, cleaning, and other preparation for installing flexible pavements.
 - b. Providing asphalt concrete paving materials.
 - c. Providing tack coat material.
 - d. Providing pavement markings where shown or indicated.
 - e. Providing quality controls and testing.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before flexible paving Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 31 23 05, Excavation and Fill.
 - 3. Section 32 16 13, Concrete Curbs, Gutters and Sidewalks.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. AASHTO M320, Specification for Performance-Graded Asphalt Binder.
 - 2. AASHTO MP1a, Specification for Performance-Graded Asphalt Binder.
 - 3. AI MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.
 - 4. ASTM C1371, Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
 - 5. ASTM C1549, Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
 - 6. ASTM D242/D242M, Specification for Mineral Filler For Bituminous Paving Mixtures.
 - 7. ASTM D692/D692M, Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
 - 8. ASTM D946/D946M, Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
 - 9. ASTM D977, Specification for Emulsified Asphalt.
 - 10. ASTM D1073, Specification for Fine Aggregate for Bituminous Paving Mixtures.
 - 11. ASTM D1188, Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.

12. ASTM D2726, Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
13. ASTM D2950, Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
14. ASTM D3549, Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
15. ASTM D6690, Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
16. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
17. ASTM E408, Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
18. ASTM E1918, Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
19. ASTM E1980, Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
20. FS TT-P-115, Paint, Traffic, Highway, White and Yellow.
21. USGBC LEED-NC, Reference Guide, For New Construction and Major Renovation.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Asphalt Concrete Production Facility:
 - a. Production facility for asphalt concrete, tack coat materials, and other bitumastic materials shall be certified by the Florida Department of Transportation for furnishing such materials for Florida Department of Transportation highways.
2. CONTRACTOR's Testing Laboratory:
 - a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials provided under this Section.
 - b. Do not employ the same laboratory hired by OWNER for field quality control testing under the "Field Quality Control" Article of this Section.
 - c. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29, Testing Laboratory Services Furnished by Contractor.
 - d. Testing laboratory shall be experienced in the types of testing required.
 - e. Selection of testing laboratory is subject to ENGINEER's acceptance.

B. Regulatory Requirements:

1. Reference Specifications and Details:
 - a. Comply with applicable requirements of Florida Department of Transportation Standard Specifications.
2. Obtain required highway and street rights-of-way work permits.
3. Jurisdiction:
 - a. Paved areas to be constructed are jurisdiction of Owner.

C. Quality Assurance Testing:

1. Quality assurance testing is in addition to source quality control testing, when required, and field quality control testing required under Article 3.4 of this Section.

2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at OWNER's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
3. CONTRACTOR's Quality Assurance Testing Laboratory Scope:
 - a. Use of testing laboratory shall not relieve CONTRACTOR of responsibility for providing materials and the Work in compliance with the Contract Documents.
 - b. Quality assurance testing laboratory shall perform the following, unless evidence of material compliance with reference specifications indicated in Paragraph 1.3.B of this Section, is submitted to ENGINEER by CONTRACTOR and asphalt concrete production facility:
 - 1) Test in accordance with reference specifications indicated in Article 1.3 of this Section. In lieu of quality assurance testing, submit evidence and certification of material compliance with reference specifications. When evidence of conformance submitted is not acceptable to ENGINEER, perform quality assurance testing.
 - c. To facilitate testing services, CONTRACTOR shall:
 - 1) Secure and deliver to testing laboratory and ENGINEER (when requested by ENGINEER) representative Samples of materials that CONTRACTOR proposes to furnish and that are required to be tested.
 - 2) Furnish such labor as is necessary to obtain and handle Samples at the Site or at asphalt concrete production facility and other material sources.
 - 3) Advise testing laboratory and ENGINEER sufficiently in advance of operations to allow for completion of quality assurance tests and for the assignment of personnel.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Submit the proposed asphalt concrete mix design for each asphalt concrete material, and other bituminous materials, required under this Section, providing complete data on materials, including location in the Work, source, material content and percentages, temperatures, and all other pertinent data. Indicate proportion of bituminous material from reclaimed asphalt pavement.
 - b. Proposed gradation for each aggregate to be used in flexible paving. Submit gradation test results for the same material furnished on a previous project. Indicate the proportion of reclaimed asphalt pavement.
 - c. In lieu of the information required under Paragraphs 1.4.A.1.a and 1.4.A.1.b, above, submit certificates of compliance with the reference specifications indicated in Article 1.3 of this Section, for each for the following:
 - 1) Each mix design required.
 - 2) Bituminous materials required.
 - 3) Aggregates to be used in flexible paving, from each material source and each required gradation.
 - 4) Density of uncompacted asphalt concrete material.

- 5) Density of previously-compacted, previously-tested asphalt concrete material.
 - 6) Density and voids analysis for each asphalt concrete material test specimen.
 - 7) Evidence of asphalt concrete plant inspection and compliance with the reference specifications indicated in Article 1.3 of this Section.
 - 8) Proportion of reclaimed asphalt pavement in bituminous materials and aggregate.
- 2. Product Data:
 - a. Manufacturer's complete product data on all pavement marking materials proposed for use, including product literature, specifications, and recommended application techniques and other installation data.
- B. Informational Submittals: Submit the following:
 - 1. Quality Assurance Test Data Submittals and Source Quality Control Submittals:
 - a. Submit for quality assurance tests and source quality control tests required.
 - 2. Delivery Tickets:
 - a. Submit copy of delivery ticket for each load of asphalt concrete, tack coat materials, and other materials obtained from asphalt concrete production facility, signed by CONTRACTOR
 - 3. Field Quality Control Submittals:
 - a. Submit results of required field quality control testing.
 - 5. Qualifications:
 - a. Asphalt concrete production facility, when required by ENGINEER.
 - b. CONTRACTOR's testing laboratory, when required by ENGINEER.

1.5 SITE CONDITIONS

- A. Weather Limitations:
 - 1. Temperature:
 - a. For base course and binder course paving lifts equal to or greater than two inches thickness, atmospheric temperature shall be 40 degrees F and rising.
 - b. For surface course paving or other pavement courses in lifts less than two inches thick, temperature of surface on which pavement is to be placed shall be 50 degrees F or greater.
 - 2. Prohibitions:
 - a. Do not place flexible paving materials when weather is foggy or during precipitation.
 - b. Do not place flexible paving materials when the base on which the material will be placed contains moisture in excess of optimum.
 - c. Place flexible paving materials only when ENGINEER concurs that weather conditions are suitable.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. System Description:

1. Provide subbase course of the thickness shown or indicated, in accordance with Section 31 23 05, Excavation and Fill.

2.2 ASPHALT CONCRETE MIXES

- A. Asphalt Concrete Mixtures: Provide the following materials designed and manufactured in accordance with reference specifications indicated in Article 1.3 of this Section:
 1. Base Course: FDOT Standard Specification Section 234
 2. Binder Course: FDOT Standard Specification Section 234
 3. Surface Course (Wearing Course, Top Course): FDOT Standard Specification Section 337

2.3 BITUMINOUS MATERIALS

- A. Bituminous Materials for Asphalt Concrete:
 1. Bituminous materials for asphalt concrete shall comply with the reference specifications indicated in Article 1.3 of this Section, for the asphalt concrete mixes specified.
- B. Tack Coat:
 1. Tack coat shall be emulsified asphalt.
 2. Provide as per FDOT Standard Specification Section 300
- C. Crack Sealant:
 1. Provide as per FDOT Standard Specification Section 411

2.4 AGGREGATES IN FLEXIBLE PAVEMENTS

- A. Aggregates for Asphalt Concrete – General:
 1. Aggregate materials used in flexible pavement shall be in accordance with the reference specifications indicated in Article 1.3 of this Section, for the asphalt concrete mix designs indicated.
 2. Aggregate material shall comply with the following:
 - a. Coarse Aggregate: ASTM D692/D692M; crushed stone, gravel, or blast furnace slag.
 - b. Fine Aggregate: ASTM D1073; natural sand or sand manufactured from stone, gravel, or blast furnace slag.
 - c. Mineral Filler: Finely-ground mineral particles such as limestone dust, portland cement, or other inert material complying with ASTM D242/D242M, and free of foreign matter.

2.5 PAVEMENT MARKING MATERIALS

- A. Material:
 1. Pavement marking paint shall have chlorinated rubber base.
 2. Factory-mixed, quick-drying and non-bleeding, complying with FS TT-P-115, Type III.
- B. Colors:
 1. Roadway Center Markings Between Opposing Traffic Lanes: Yellow.

2. Roadway Side Striping: White, unless otherwise shown or specified. On roads with divided median, right-side striping of each direction shall be white, and left-side striping shall be yellow.
3. Roadway Miscellaneous Lane Markings (turn lane arrows and text): White.
4. No-Parking Areas: Yellow.
5. Handicap Parking Spaces: Unless otherwise indicated with signs, provide handicap symbol on pavement with white paint on blue background.

2.6 SOURCE QUALITY CONTROL

- A. Tests: Obtain and test samples in accordance with AI MS-2. Testing is responsibility of CONTRACTOR or asphalt concrete production facility. Submit results to ENGINEER.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine the subbase and base on which flexible paving will be installed. Notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Do not place materials on subgrades, or subbase that is muddy or has water thereon.

3.2 PREPARATION

- A. Preparation: Before starting installation of flexible paving, perform the following:
 1. Grade Control: Establish and maintain throughout flexible paving installation the required lines and grades, including crown and cross-slope for each asphalt concrete course during construction operations.
 2. Prepare subgrade and provide subbase for flexible pavement in accordance with Section 31 23 05, Excavation and Fill. Before installing flexible pavement, obtain ENGINEER's concurrence that subgrade and subbase are suitable for installing flexible pavement.
 3. Coordinate placement of flexible pavement with the Work included under Section 32 16 13, Concrete Curbs, Gutters and Sidewalks, and Work including drainage structures, manholes, valve boxes, and similar items.
 4. Provide appropriate maintenance and protection of traffic measures during placement of pavement.
- B. Milling:
 1. Perform milling of existing pavement where shown or indicated.
 2. "Milling" consists of the milling, shaping, and removing portions of existing surfaces by cold milling process and subsequent cleaning.
 3. Milling Equipment:
 - a. Milling machines shall be power-operated, self-propelled machines capable of removing the desired thickness of existing surfaces. Machines shall have sufficient power, traction, and stability to accurately maintain depth of cut and slope. Machines shall produce a finished profile and cross slope to within 1/4 inch of that required and

- shall produce uniform surface texture free of gouges and ridges greater than 3/8-inch deep.
- b. Machines shall be equipped with a means to control dust and other particulate matter created by the cutting action.
- c. Provide equipment that removes milled material as quickly as the rate of milling.
- d. Use vacuum trucks, street sweepers or power brooms to clean milled surfaces.
- 4. Milling Operations:
 - a. Perform milling to so that, when final course of pavement is placed, required elevations and grades are provided. Where required, establish a taut reference string line to control line and grade of milling.
 - b. Minimize the time between milling and placement of pavement over milled surface.
 - c. Areas not accessible to the milling machine, such as around or adjacent to drainage structures, manholes, curbs, and transverse joints on structures, may be removed by a small milling machine, handwork or other method acceptable to ENGINEER.
 - d. Remove milled material as soon as it is milled. Remove fines and other material prior to opening milled area to traffic. Control objectionable dust emissions. When traffic has been allowed into milled area or when more than 48 hours have elapsed since milling, clean the milled area again prior to applying tack coat.
 - e. Maintain drainage to drainage inlets and other drainage structures in a manner acceptable to ENGINEER.
 - f. Properly dispose of milled material at a location away from the Site.
- C. Surface Preparation:
 - 1. Repair surface defects in existing pavement to provide uniform surface to receive new pavement.
 - 2. Provide crack sealant to completely fill cracks more than 1/16-inch wide in areas shown or indicated on the Drawings.
 - 3. Clean existing surfaces over which asphalt concrete pavement will be installed, by removing from the surface foreign material, excess asphalt concrete, excess joint sealant, and crack filler, and other undesirable matter.
 - 4. Provide tack coat as indicated in Article 3.3 of this Section.

3.3 INSTALLATION OF FLEXIBLE PAVING

- A. General:
 - 1. Provide final pavement surfaces of uniform texture, at required grades and cross-sections.
 - 2. Construct roadways to the lines, grades, and typical sections shown or indicated.
- B. Installation of Asphalt Concrete:
 - 1. Asphalt concrete mixture shall be transported to the site of paving and placed as soon as possible after mixing.
 - 2. Placement of each asphalt concrete course shall be completed over the full width of the section under construction during each day's paving operations.

3. Spread and finish asphalt concrete courses by means of self-propelled mechanical spreading and finishing equipment. Compacted thickness of layers placed shall not exceed 150 percent of specified thickness unless approved in writing by ENGINEER.
4. Compaction:
 - a. Rollers:
 - 1) Use sufficient rolling equipment to satisfactorily compact and finish the quantity of asphalt concrete placed. There shall be not less than two rollers on the Project at all times. When acceptable to ENGINEER, one of the rollers may be a pneumatic-tire roller.
 - 2) During rolling operations, roller speed shall not exceed three miles per hour. When sufficient number of rollers is not available, reduce the quantity of asphalt concrete placed to accommodate the available rollers' speed.
 - 3) Required rollers shall be at the Site, in acceptable operating condition, prior to placing of asphalt concrete.
 - 4) Use of vibratory rollers in lieu of steel-wheeled rollers is acceptable, however when thickness of asphalt concrete is one-inch or less, rolling shall be in the static mode.
 - b. Rolling of initially-placed asphalt concrete material, or breakdown rolling, shall begin as soon as the asphalt concrete mixture will bear the roller without undue displacement.
 - c. Rolling shall be longitudinal, overlapping on successive trips by not less than one-half roller rear wheel width, and not more than three-quarters of roller rear wheel width. Alternate trips of the roller shall be of slightly different lengths.
 - d. At all times, roller motion shall be slow enough to avoid displacing the asphalt concrete.
 - e. Operate rollers continuously from breakdown of laid asphalt concrete through finish rolling.
 - f. Perform finish rolling using a steel-wheeled roller or a vibratory steel-wheel roller operating in the static mode.
 - g. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.
 - h. At each location not accessible to roller, thoroughly compact asphalt concrete with tampers and finish, where necessary, with a hot smoothing iron to provide uniform, smooth layer over the entire area so compacted.
5. Each compacted asphalt concrete course shall be within plus or minus 1/4-inch of the indicated thickness.
6. Placement of Adjacent Strips of New Asphalt Concrete:
 - a. When more than one width of asphalt concrete material will be placed, a six-inch wide strip of asphalt concrete adjacent to the area on which the future material is to be placed shall not be rolled until such future material is placed.
 - b. Do not leave the unrolled strip unrolled for more than two hours after placement, unless the six-inch unrolled strip is first heated with a joint heater.
 - c. After the first strip or width of asphalt concrete is compacted, place, finish, and compact the second width or strip as required for the first width, except that rolling shall be extended to include the six-inch strip of the first width not previously compacted.

C. Construction Joints:

1. Construction joints shall be made in such a manner as to ensure a neat junction, thorough compaction, and bond throughout.
2. Provide a transverse joint extending over the full width of the strip being laid and at right angles to its centerline at end of each workday and at other times when the placement of hot-mix asphalt concrete will be suspended for a period of time that will allow asphalt concrete mixture to chill.
3. Thoroughly compact by rolling the forward end of a freshly laid strip of asphalt concrete before the asphalt concrete mixture becomes chilled. When the Work is resumed, the end shall be cut vertically for the full depth of the layer.

D. Joining of Pavements:

1. When pavement is to join existing or previously-laid pavement, the existing or previously-laid pavement shall be neatly and carefully edged to allow for overlapping and feathering of the subsequent course of asphalt concrete material.
2. Where new pavement is to meet existing pavement, the existing pavement shall be sawcut and notched.
3. Where new pavement will meet existing asphalt pavement, remove existing pavement 12 inches onto undisturbed existing pavement course at edges where new pavement will meet existing pavement.
4. Tack Coat:
 - a. Provide tack coat material at the following locations:
 - 1) At edges where new pavement will connect to existing or previously-installed pavement.
 - 2) On surface of existing or previously-installed pavement course over which new pavement will be installed, prior to placement of the subsequent pavement course. Tack coat may be deleted when a succeeding layer of asphalt pavement is being applied over a freshly-placed asphalt pavement course that has been subjected to very little or no traffic, with approval of ENGINEER
 - 3) Where new pavement will abut curbing, concrete gutters, drainage structures and frames, manhole cover frames, valve boxes, and similar items.
 - b. Tack Coat Installation: Install tack coat immediately prior to installing pavement. Place pavement while tack coat is wet. Apply tack coat in accordance with reference specification indicated in Article 1.3 of this Section.
 - b. Tack Coat Installation:
 - 1) Install tack coat immediately prior to installing pavement. Place pavement while tack coat is wet. Surfaces to which tack coat will be applied shall be clean and dry. Clean surfaces by sweeping or washing prior to applying tack coat.
 - 2) When tack coat is diluted, dilution shall be by tack coat manufacturer, not CONTRACTOR. When using diluted tack coat, dilute one part water to one part tack coat emulsion. Dilute by adding water to emulsion; do not dilute by adding emulsion to water.
 - 3) Apply at the following rates for the surface to which tack coat will be applied:

Surface to Which Tack Coat will be Applied	Application Rate (gallons per cubic yard)		
	Residual (1)	Undiluted (2)	Diluted 1:1 with Water
New hot-mix asphalt concrete	0.03 to 0.04	0.05 to 0.07	0.10 to 0.13
Oxidized hot-mix asphalt concrete	0.04 to 0.06	0.07 to 0.10	0.13 to 0.20
Milled hot-mix asphalt concrete	0.06 to 0.08	0.10 to 0.13	0.20 to 0.27
Milled portland cement concrete	0.06 to 0.08	0.10 to 0.13	0.20 to 0.27
Portland cement concrete, and metallic frames	0.04 to 0.06	0.07 to 0.10	0.13 to 0.20
Notes: (1) "Residuals" is the application rate of only the asphalt binder content of the emulsion. (2) "Undiluted" is the application rate of the undiluted emulsion.			

- 4) Apply tack coat by pressure-type distributor trucks with insulated tanks. Hand-spraying, using hose or bar, through a gear pump or air tank is acceptable for resurface work, corners, or tacking of vertical edges. Maintain temperature in the distribute between 75 and 130 degrees F.
- 5) Provide uniform coverage. Do not use tack coat application equipment that does not performs satisfactorily.

E. Curing:

1. Do not allow traffic onto pavement until directed by ENGINEER. Traffic will not be allowed on new asphalt concrete pavement until surface temperature is less than 140 degrees F.
2. Hold construction traffic on new pavement to a minimum as acceptable to ENGINEER.

F. Asphalt Concrete Curbs: Provide extruded asphalt curbs of the height and profile indicated on the Drawings.

G. Defective Pavement Work:

1. When directed by ENGINEER, remove and replace defective flexible paving Work. Cut out such areas of defective pavement and fill with fresh asphalt concrete materials, compacted to required density.

3.4 FIELD QUALITY CONTROL

A. Site Tests:

1. Responsibility:
 - a. OWNER's field quality control testing laboratory will:
 - 1) Perform field density tests to verify that required compaction of asphalt materials has been obtained.

- 2) Test the proposed materials for compliance with the Contract Documents, as directed by ENGINEER.
- 3) Submit reports of all test results to ENGINEER and CONTRACTOR.
- b. Authority Field Quality Control Testing Laboratory:
 - 1) Technicians representing the testing laboratory will inspect materials at the Site and perform required testing. When the materials furnished or Work performed do not comply with the Contract Documents, field quality control testing laboratory technician shall direct the attention of ENGINEER and CONTRACTOR to such non-compliance.
 - 2) Testing laboratory personnel shall not act as foreman or perform other duties for CONTRACTOR. The Work will be checked as it progresses, but failure to detect defective Work shall not in any way prevent the later rejection of such defective Work when defect is discovered. Failure to detect defective Work as it occurs does not obligate ENGINEER to final acceptance. Testing laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, nor to approve or accept any portion of the Work.
2. Asphalt Concrete Mix Temperature: Measure temperature at time of placement, record, and submit to ENGINEER.
3. Surface Smoothness:
 - a. Test finished surface of each flexible paving course for smoothness, using a ten-foot straightedge applied parallel to and at right angles to centerline of paved areas.
 - b. Check surfaced areas at intervals as directed by ENGINEER.
 - c. Surfaces will be acceptable relative to smoothness when measurements are equal to or less than the following:
 - 1) Base Course: 3/8-inch vertical in ten feet horizontal.
 - 2) Binder Course: 3/8-inch vertical in ten feet horizontal.
 - 3) Surface Course (Wearing Course): 1/4-inch vertical in ten feet horizontal.
 - 4) Crowned Surfaces:
 - 5) Test crowned surfaces with a crown template, centered and at right angles to the crown.
 - 6) Surfaces will be acceptable when variance is equal to or less than 1/4-inch from the template.
 - d. Elevation: Finished surface of pavement shall be within plus or minus 1/2-inch of elevations shown or indicated.
4. Density:
 - a. Test Method: ASTM D2950; test one sample every 1,000 square yards of pavement. Test for each asphalt concrete course installed.
 - b. In addition, when directed by ENGINEER, compare density of in-place flexible paving materials against laboratory specimen or certificates on same asphalt pavement mixture, using nuclear density device.
 - c. Criteria for Acceptance: Density of in-place asphalt pavement material shall be not less than 90 percent of the recorded laboratory specimen or certificate density. Density shall be not greater than 98 percent.
5. Thickness of Asphalt Concrete Pavement Thickness: Measure in accordance with ASTM D3549; obtain and test one core sample from every **1,000 square yards** compacted pavement. Comply with thickness tolerance specified in Article 3.3 of this Section.

6. Repair holes from test specimens in accordance with this Section's requirements for repairing defective Work.

3.5 ADJUSTING

- A. Frames and Covers:
 1. Set frames of drainage structures, manholes, valve boxes, and similar items to final grade. Adjust frames of existing structures and frames furnished under other Sections. Frames shall be substantially similar elevation to finished surface course of pavement.
 2. Replace covers and gratings of existing structures immediately following adjusting associated frames. Install covers and gratings of structures provided under the Project as quickly as possible.
 3. Where there is a delay between adjusting of frames and installation of surface course, provide temporary bituminous material around perimeter of each frame to smooth vehicle access over the frame. Maintain and repair temporary bituminous material as required until placement of surface course. Remove temporary bituminous material before installing surface course.
- B. Pavement Adjustment:
 1. Repair or replace in manner acceptable to ENGINEER areas of pavement that are observed to pond or collect water.

3.6 CLEANING

- A. Cleaning: After completing the paving operations, clean surfaces of excess or spilled bituminous materials, excess asphalt concrete, and foreign matter.

3.7 PROTECTION

- A. Protect finished pavement until pavement has become properly hardened and cool.
- B. Cover openings of drainage structures, manholes, valve boxes, and similar items in the paved area until permanent coverings are provided.

3.8 PAVEMENT MARKINGS

- A. Provide pavement markings at the locations shown or indicated, in accordance with Section 09 91 00, Painting.
- B. Pavement Markings: Provide pavement markings where shown or indicated.
 1. Preparation:
 - a. Sweep surface with power broom supplemented by hand brooms to remove loose material and dirt.
 - b. Do not begin marking bituminous concrete pavement until approved by ENGINEER.
 - c. When reflective glass beads are required, mix with paint prior to paint application.
 2. Application:
 - a. Using mechanical equipment, provide uniform, straight edges in two separate coats. Apply in accordance with paint manufacturer's recommendations.

+ + END OF SECTION + +

SECTION 32 16 13

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete curbs, gutters, and sidewalks.
2. Types of Work required under this Section include:
 - a. Conventionally-formed or machine-formed curb.
 - b. Conventionally-formed or machine-formed curb and gutter.
 - c. Conventionally-formed or machine-formed curb and sidewalk.
 - d. Conventionally-formed or machine-formed curb, gutter, and sidewalk.
3. Width, thickness, geometry, and extent of curb, gutter, and sidewalk shall be as shown or indicated on the Drawings.
4. Requirements for concrete sidewalks apply to concrete driveways, unless otherwise shown or specified, or unless concrete pavement requirements are included in the Contract Documents.

B. Related Sections:

1. Section 03 00 05, Concrete.
2. Section 07 92 00, Joint Sealants.
3. Section 31 23 05, Excavation and Fill.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. AASHTO M252, Specification for Corrugated Polyethylene Drainage Pipe.
2. ASTM D1248, Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Installer:
 - a. Installer shall have not less than two years experience installing concrete curbs, gutters, and sidewalks similar to those required for the Work.
 - b. When required by ENGINEER, submit record of experience documenting not less than three successful, completed projects. For each project, submit the following information: project name, location of project, approximate quantity of concrete curb, gutter, and sidewalk constructed by installer, contract price of concrete curb, gutter, and sidewalk construction, and name and contact information for project owner and the project's construction-phase engineer.
 - c. When the Work includes 65 cubic yards or more of curb, sidewalk, and gutter concrete, furnish services of an ACI-certified concrete

flatwork finisher to supervise finishing. Submit proof of ACI flatwork certification prior to concrete placing.

- B. Regulatory Requirements:
 - 1. Reference Specifications and Details:
 - a. Comply with applicable requirements of Florida Department of Transportation.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Submit concrete mix design when mix design is different from that submitted under Division 03 Sections on concrete. Submit in accordance with Division 03 Sections on concrete.
 - b. Proposed reinforcing materials.
 - c. Schedule of proposed underdrain piping sizes and materials by location in the Project.
 - 2. Product Data:
 - a. Concrete Materials: Submit Supplier's technical information for materials proposed for use, when concrete materials are different from those submitted under Division 03 Sections on concrete.
 - b. Reinforcing Steel: Submit fabricator's technical information, including catalog information and specifications, for materials proposed for use, sufficient for ENGINEER to verify compliance with the Contract Documents.
 - c. Expansion Joint Filler: Submit Supplier's technical information, including manufacturer's product data, brochure, and specifications, for materials proposed for use, when materials are different from those submitted under Division 03 Sections on concrete.
 - d. Underdrain Piping: Manufacturer's product data, brochure, and specifications for underdrain piping proposed for use.
- B. Informational Submittals: Submit the following:
 - 1. Certifications:
 - a. When concrete materials are different from those approved under Division 03 Sections on concrete, submit certifications as required in concrete Specifications Sections referred to in this Section.
 - 2. Site Quality Control Submittals:
 - a. Concrete test results for the Work included under this Section.
 - 3. Qualifications Statements:
 - a. Installer, when requested by ENGINEER.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with Division 03 Sections on concrete referenced in this Section.

1.6 SITE CONDITIONS

- A. Weather and Temperature Limitations:
 - 1. When temperature and environmental conditions warrant, comply with requirements for cold weather placing and hot weather placing under

Division 03 Sections referenced in this Section, unless otherwise required under this Section.

2. Temperature of aggregate base material under concrete shall be 39 degrees F or higher. Aggregate base material shall not have snow, ice, frost, or standing water on its surface at the time of concrete placing. Use of insulating materials and heating equipment may be required before concrete placing begins.
3. Discontinue concrete placing when the air temperature falls below 39 degrees F. Do not place concrete in the rain.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Aggregate Bedding Material for Curbs, Sidewalks, and Gutters: Select fill in accordance with Section 31 23 05, Excavation and Fill, unless otherwise shown or indicated.
- B. Concrete Materials:
 1. Comply with applicable requirements of: Section 03 00 05, Concrete; including requirements for formwork, concrete materials, admixtures, bonding materials, curing materials, and others as required.
 2. Concrete Mix, Design, and Testing:
 - a. Comply with applicable requirements of Section 03 00 05, Concrete , for concrete mix design, sampling, and testing, and quality control.
 - b. Design the mix to produce concrete of properties of compressive strength, slump range, and air content as specified in Section 03 00 05, Concrete .
 - c. When machine-formed equipment is used for constructing concrete curbs, sidewalks, or gutters, concrete so placed shall have properties in accordance with Section 03 00 05, Concrete, except that maximum slump shall be 2.5 inches and air content shall be two percent of design.
- C. Expansion Joint Material:
 2. Joint Sealant: For joint sealants and accessories used on expansion joints, comply with Section 07 92 00, Joint Sealants.
- D. Perforated Underdrain Piping:
 1. Provide the material shown or indicated. When material is now shown or indicated, provide the following materials manufactured in accordance with reference specifications indicated in Article 1.3 of this Section:
 2. Material: Circular, perforated, corrugated polyethylene pipe, complying with Section 440 of FDOT Standard Specifications."
 3. Size: Provide underdrain piping of the sizes shown or indicated on the Drawings. For circular underdrain piping, unless otherwise indicated, use pipe with inside diameter of not less than four inches.
 4. Underdrain Bedding Material: Shall be as shown on the Drawings. If not shown, material shall be pipe bedding stone in accordance with Section 31 23 05, Excavation and Fill.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine subgrade, subbase, and conditions under which the Work is will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are been corrected.
- B. Subgrade:
 - 1. Verify that earthwork is completed to correct line and grade.
 - 2. Verify that subgrade is smooth, properly compacted, and free of frost and excessive moisture in accordance with Division 31 Section on excavation and fill.
 - 3. Do not commence the Work under this Section until conditions are satisfactory.

3.2 AGGREGATE BASE FOR CURBS, SIDEWALKS, AND GUTTERS

- A. Aggregate Base under Curb, Gutter, or Sidewalk:
 - 1. Install aggregate fill in accordance with Section 31 23 05, Excavation and Fill . Properly compact aggregate fill to thickness shown or indicated in the Contract Documents.
 - 2. When thickness of aggregate base is not shown or indicated, provide six-inch thick aggregate base under curbs, sidewalks, and gutters.

3.3 PERFORATED UNDERDRAIN PIPING

- A. Preparation for Underdrain Piping:
 - 1. Provide leveled and compacted bed of the required underdrain bedding material just prior to installing the underdrain piping. Slope bedding as shown and as required for drainage of underdrain piping.
- B. Installation of Underdrain Piping:
 - 1. Install underdrain piping in accordance with pipe manufacturer's recommended installation procedures.
 - 2. Upgrade end of corrugated polyethylene underdrain pipe shall be closed with a solid plastic cap.
 - 3. Unless otherwise shown or required by ENGINEER, install underdrain pipe with perforations down.
 - 4. Install piping to drain to suitable discharge location.
 - 5. When polyethylene underdrains are daylighted through the side slope protect end of pipe from sunlight by providing section of corrugated steel or aluminum pipe, not less than three feet long, at the outlet. Extend the metal pipe not less than six inches into the ground and shall overlap the perforated underdrain piping by not less than the diameter of the underdrain pipe.
- C. Acceptability of Underdrain Piping:
 - 1. With ENGINEER, visually inspect installed underdrain piping after installation and prior to filling and placing additional construction over underdrain piping. Piping will be acceptable when it is verified as installed on acceptable grade for drainage, is installed in accordance with the Contract Documents, and is free of damage and defects.

3.4 CONSTRUCTION OF FORMS

- A. Conventional Forms:
 - 1. Set forms to line and grade. Forms shall be free from warp.
 - 2. Install forms along full length of curb, gutter, and sidewalk.
 - 3. Forms shall extend to the full depth of the curb, sidewalk, and gutter (as applicable) and be secured so no displacement occurs during concrete placing.
- B. At CONTRACTOR's option, machine-formed concrete curbs, sidewalks, and gutters are acceptable.

3.5 REINFORCING

- A. General:
 - 1. Locate, place, and support reinforcing in accordance with the Drawings.
 - 2. Size of reinforcing shall be as shown or indicated in the Contract Documents.
 - 3. Unless otherwise shown or indicated, locate reinforcing for sidewalks at the mid-depth point in the concrete slab.
- B. When machine-formed concrete curbs, sidewalks, and gutters are provided, reinforcing shall be suitable for the forming/placing method, at no additional cost to OWNER. Obtain ENGINEER's approval of alternate reinforcing prior to placing concrete.

3.6 CONCRETE PLACING

- A. General:
 - 1. Comply with this Section relative to mixing and placing concrete.
- B. Placing:
 - 1. Curbs and Gutters: Place concrete using methods that prevent segregation of the mix. Consolidate concrete along face of forms with an internal vibrator.
 - 2. Sidewalks: Place concrete in one-course, monolithic construction, for full width and depth of sidewalk.
 - 3. Machine-Formed:
 - a. At CONTRACTOR's option, automatic curb, gutter, and sidewalk machine may be used for installing concrete.
 - b. Machine forming shall produce curbs, gutters, and sidewalks of required cross-section, lines, grades, finish, and jointing, as specified for conventionally-formed concrete.
 - c. At curb cuts and driveway entrances, cut-out concrete and hand-finish the curbing to provide the required curb cut or driveway entrance, as applicable.
 - d. If results do not comply with the Contract Documents, remove and replace at no additional cost to OWNER.
- C. Curbs:
 - 1. Provide curb-cuts and driveway entrances for vehicle passage and pedestrian passage where shown, and when not shown but where existing sidewalks and curbs are being replaced, provide curb-cut or driveway

entrance (as applicable) at location of existing driveways and pedestrian access ramps in sidewalks.

2. Neatly form transitions from curb to curb-cut or driveway entrance.
3. Unless otherwise shown or indicated, top of curb at curb-cut or driveway entrance shall be not greater than 1/4-inch above elevation of finished pavement surface.

D. Gutters:

1. Unless otherwise shown or indicated, top of gutter shall be not greater than 1/4-inch above elevation of finished pavement surface.

3.7 JOINTS

A. General:

1. Provide expansion joints, contraction joints, and construction joints in concrete curbs, gutters, and sidewalks.
2. Provide expansion, contraction, and construction joints perpendicular to formed faces of curb, gutter, or sidewalk.
3. Construct transverse joints at right angles to the Work centerline and as shown.

B. Contraction Joints: Provide joints as indicated below:

1. Curbs and Gutters: Provide at intervals of ten feet on centers. Joint shall be not less than 1/8-inch and not more than 1/4-inch in width, and have a depth of 1.5 inches.
2. Sidewalks: Provide at intervals of five feet on centers. Joint shall be not less than 1/8-inch and not more than 1/4-inch in width, and have a depth of not less than one-third the total thickness of concrete sidewalk.
3. Joints may be formed or sawcut.

C. Construction Joints: Place construction joints at locations where concrete placing operations are stopped for more than 30 minutes, except where such pours terminate at expansion joints.

D. Expansion Joints:

1. General: Provide preformed expansion joint filler at locations indicated. When curb, gutter, or sidewalk is not poured monolithically, provide expansion joints where each abuts the other.
2. Curbs and Gutters: Provide 11/16-inch wide preformed expansion joint filler at the intervals of 30 feet along curb and gutter; at expansion joints in pavement; at movable structures (such as bridges); and between curb or gutter and: structures, returns, and at 30-foot intervals along length of curb or gutter.
3. Sidewalks: Provide 1/2-inch wide preformed expansion joint filler at 30-foot intervals along length of sidewalk and at all joints between sidewalk and: curb, gutters, pavement, buildings, drainage structures, utility metal appurtenances such as manhole cover frames and valve boxes, and similar construction.
4. Place top of expansion joint material not less than 1/2-inch or more than one-inch below concrete surface. Apply joint sealer on top of expansion joint material flush with concrete surface, and in accordance with sealant manufacturer's instructions and Section 07 92 00, Joint Sealants.

3.8 CONCRETE FINISHING

- A. Smooth exposed surface by screeding and floating. Perform hand-screeding when conventionally-formed concrete is provided.
- B. Work edges of gutter and sidewalks, back top edge of curb, and transverse joints; and round to 1/4-inch radius.
- C. Complete surface finishing by drawing a fine-hair broom across surface, perpendicular to line of traffic.

3.9 CURING

- A. General:
 - 1. Protect and cure finished concrete curbs, gutters, and sidewalks, in accordance with Section 03 00 05, Concrete.
 - 2. Cure driveways and sidewalks at driveways for not less than three days prior to opening to vehicle traffic. In colder weather, as indicated in Article 1.6 of this Section, curing period shall be not less than six days prior to opening to vehicle traffic unless other provisions to determine strength are provided and approved by ENGINEER.

3.10 REPAIR AND CLEANING

- A. Repair or replace broken or defective curbs, gutters, and sidewalk as directed by ENGINEER.
- B. Sweep the concrete curb, sidewalk, and gutter Work and wash free of stains, discolorations, dirt, and other foreign material.

+ + END OF SECTION + +

SECTION 32 92 00

LAWNS AND MEADOWS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all lawns and meadows.
2. Extent of lawns and meadows is shown.
3. Types of products required include the following.
 - a. Topsoil.
 - b. Lawn grass seed.
 - c. Meadow grass seed mixture.
 - d. Wildflower meadow seed mixture.
 - e. Plugs.
 - f. Sprigs.
 - g. Sod.
 - h. Inorganic soil amendments.
 - i. Organic soil amendments.
 - j. Fertilizers.
 - k. Mulches.
 - l. Erosion-control materials.
 - m. Accessories.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, lawns and meadows.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. Association of Official Analytic Chemists, (AOAC).
 - a. Official Methods of Analysis of AOAC International.
2. Association of Official Seed Analysts, (AOSA).
 - a. Journal of Seed Technology; Rules for Testing Seeds.
3. American Society of Agronomy, (ASA).
 - a. Reference No. 1 - Methods of Soils Analysis, Soil Science Society of America, Incorporated.
4. American Society for Testing and Materials, (ASTM).
 - a. ASTM B 221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
 - b. ASTM C 602, Specification for Agricultural Liming Materials.
 - c. ASTM D 75, Practice for Sampling Aggregates.
 - d. ASTM D 422, Test Method for Particle Size Analysis of Soil.
 - e. ASTM D 977, Specification for Emulsified Asphalt.

- f. ASTM D 2487, Practice for Classification of Soils for Engineering Purposes (United Soil Classification System).
- g. ASTM D 5268, Specification for Topsoil Used for Landscape Purposes.
- h. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- i. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.
- 5. Turfgrass Producers International, (TPI).
 - a. Guideline Specifications to Turfgrass Sodding.

1.3 DEFINITIONS

- A. The term "finish grade" shall be used to describe the finished surface elevation of planting soil.
- B. The term "manufactured topsoil" shall be used to describe soil produced off-Site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil acceptable as a component of loam.
- C. The term "loam" shall be used to describe topsoil that has been mixed with additional organic and inorganic additives, as specified.
- D. The term "percentage pure live seed" shall be defined as the percent (%) purity multiplied by percent (%) germination divided by 100 to equal the percent pure live seed (PLS) and shall be calculated for all seed lots using each seed lots own unique purity and germination test results. A PLS pound shall be defined as the bulk weight of seed required to equal one pound of 100 percent pure, germinated seed.
- E. The term "subgrade" shall be used to describe the surface of subsoil remaining after completing excavation; or the top surface of a fill or backfill immediately beneath topsoil and which has not been tested for acceptable use as topsoil.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Engage a single landscape installer skilled, trained and with successful and documented experience in the planting of lawns and meadows and with specific skill and successful experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
 - a. Names and telephone numbers of owner, architects or engineers responsible for projects.
 - b. Approximate contract cost of the lawns and meadows.
 - c. Amount of area installed.
 - 2. Installer's Site Supervisor: Require installer to maintain an experienced full-time landscape supervisor on-Site during the time of preparation for, and planting of, lawns and meadows. Supervisor shall have achieved

- landscape or horticultural certification acceptable to governing authorities having jurisdiction at the Site.
3. Ratio of laborers to certified landscape supervisors shall not exceed 12 to one. Certified landscape supervisor shall be on-Site throughout the day-to-day performance of the Work of this Section.
 4. Application of herbicides, chemicals and insecticides shall be done by personnel licensed to perform such applications by governing authorities having jurisdiction at the Site and in accordance with each manufacturer's instructions provided on each product label.
- B. Soil-Testing Laboratory Qualifications:
1. An independent laboratory, recognized by governing authorities having jurisdiction at the Site, with the experience and capability to conduct testing indicated and that specializes in types of soil tests to be performed.
 2. To qualify for approval, an independent testing agency shall demonstrate to ENGINEER'S satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work, in accordance with ASTM E 329 and as documented according to ASTM E 548.
- C. Soil Analysis: Furnish report of soil analysis to ENGINEER, prepared by a qualified soil-testing laboratory, stating percentages of organic matter; mechanical gradation of sand, silt, and clay content in compliance with ASTM D 422; cation exchange capacity; sodium absorption ratio; deleterious materials content; pH; and mineral and plant-nutrient content of soil. Chemical analysis shall include tests for percentages of nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, iron, manganese, copper, zinc, extractable aluminum, and total soluble salts.
1. Existing On-Site Soil:
 - a. Separate soil stockpiled and proposed for use as topsoil for lawns and meadows into 1000 cubic yard piles and label with a numbering system used to reference all soil samples and test results.
 - b. Obtain a one cubic foot representative sample for each 1000 cubic yards of soil stockpiled on-Site proposed for use as topsoil for lawns and meadows, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.
 - c. Place samples taken from each stockpile, into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.
 - d. Take one cup of soil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.
 - e. Report suitability of soil as a topsoil component for lawn and meadow plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added to produce satisfactory topsoils. Include

calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of soil.

- f. In addition, all on-Site soil that will be used as topsoil shall be provided with additional compost and peat moss amendments specified, whether or not testing indicates positive need for such amendments, for such material to be used as loam.

2. Manufactured Imported Topsoil:

- a. Test each 1000 cubic yards of manufactured topsoil at the proposed source. In addition, after ENGINEER'S approval of manufactured topsoil based on results and recommendations of soil testing reports, test each 1000 cubic yards of manufactured topsoil that is delivered to the Site for conformance to results and recommended modifications of approved soil test reports. Manufactured topsoil that differs from proposed source material, after modification according to recommendations of soil test reports, shall be rejected for use in the Work.
- b. Obtain a one cubic foot representative sample for each 1000 cubic yards of manufactured topsoil proposed for lawn and meadow Work, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.
- c. Place samples taken from each stockpile into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample, taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.
- d. Take one cup of topsoil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.
- e. Report suitability of manufactured topsoil as a component for lawn and meadow plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added to produce satisfactory manufactured topsoil. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of manufactured topsoil.
- f. Organic component of manufactured topsoil shall be obtained from compost and peat moss amendments specified, for such material to be used as loam.

D. Source Quality Control:

- 1. Analysis and Standards: Package all products with manufacturer's certified analysis performed in accordance with methods established by AOAC, wherever applicable, or as specified.
- 2. Provide manufactured imported topsoil from a commercial processing facility specializing in the manufacture of topsoil.
- 3. Provide sod procured from areas having growing conditions similar to location of Site.
- 4. Machine-cut sod into rectangular sections, exercising care to retain the native soil on the roots of the sod, during stripping, transportation and planting.

5. Cut and move sod only when soil moisture conditions are such that favorable results can be expected.
6. Rectangular sections of sod may vary in length but shall be equal in width and of a size that permits the sod to be lifted and rolled without breaking.
7. Obtain sprigs from areas as close to the Site as possible. Harvest as follows:
 - a. Remove weeds before beginning harvest.
 - b. Harvest from one area in a continuous operation so that the maximum amount of sprigs are obtained.
 - c. Harvesting may be accomplished by any acceptable method.
 - d. Collect sprigs and bunch for loading.
 - e. Gather sprigs into small piles and keep moist.
 - f. Coordinate harvest and installation so that sprigs are not exposed to sun longer than 30 minutes before being covered and moistened.
 - g. Sprigs that have been heated will be rejected.
8. Seed that has been stored at temperatures, or under conditions not recommended by the seed supplier, or has become wet, moldy, or otherwise damaged, shall not be acceptable. The PLS for each seed lot shall be 75 percent, minimum.
9. Certify that all seed has been stored under conditions recommended by the seed supplier and has not been subjected to conditions damaging to PLS percentages.
10. Seed may be mixed by an approved method on-Site or at the seed supplier's facilities. If the seed is mixed on-Site, each variety shall be delivered in the original containers and shall bear the supplier's certified analysis. Where seed is mixed by the seed supplier, provide ENGINEER with the seed supplier's certified statement as to the composition of the mixture.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Schedule for lawn and meadow-planting showing anticipated planting dates for each type of Work.
 2. Product Data:
 - a. Manufacturer's product data, specifications and installation instructions for all required materials.
 - b. Composition and analysis of commercial fertilizers and all purchase receipts showing the total quantity actually purchased for this Project.
 - c. Proportions of each component contained in hydro seed mixture. Identify number of pounds of each component required for each 100 gallons of water. Include the number of square feet of lawn, grass meadow or wildflower meadow mixture that can be installed with each full tank of hydro seed mixture.
 - d. PLS for each type of seed and each seed lot. Include bulk weight of seed required to equal one pound of 100 percent pure, germinated seed.
 3. Samples:

- a. Submit 12-inch by 12-inch sheet of erosion control fabric with manufacturer's selections of standard biodegradable filler papers, and yarns.
- B. Informational Submittals: Submit the following:
 1. Certificates:
 - a. Certification of Grass and Wildflower Seed: For each grass-seed monostand and seed mixture, furnish seed supplier's certification stating the botanical and common name, and percentage by weight of each species and variety, and percentage of purity, germination and weed seed. Include the year of production and date of packaging. Certify that seed has been stored in compliance with all recommendations of the seed supplier.
 - b. Verify that sod contains no noxious weeds or other material that might be detrimental to the proposed planting.
 - c. Certificates of inspection as may be required by governmental authorities to accompany shipments, and manufacturer's certified analysis for soil amendments and fertilizer materials. For standard products submit other data substantiating that materials comply with specified requirements.
 2. Test Reports: Submit the following:
 - a. Soil analysis reports for existing soil and imported manufactured topsoil, as specified. Include recommendations for remediating existing soil into acceptable topsoil.
 3. Qualifications Data: Submit qualifications data for the following:
 - a. Landscape installer.
 - b. Landscape supervisor.
 - c. Testing agency.
 4. Source Quality Control Submittals
 - a. Written statement providing the location from which manufactured topsoil is to be obtained and the names and addresses of the suppliers.
 - b. Written statement providing the location from which the sprigs are to be obtained and the names and addresses of the suppliers.
 - c. Written statement providing the locations of the property from which the sod is to be obtained and the names and addresses of the suppliers.
- C. Closeout Submittals: Submit the following:
 1. Operations and Maintenance Data:
 - a. Submit recommended procedures to be established by OWNER for the maintenance of lawns and meadows for one full year. Submit prior to expiration of required maintenance period.
 2. Warranty Documentation:
 - a. Submit written warranty, signed by CONTRACTOR and landscape installer, as specified.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials:
 1. Do not deliver seed, sprigs, plugs or sod until Site conditions are ready for installation.

2. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery.
 3. Deliver seed in undamaged, original containers, sealed by the supplier and indicating compliance with approved Shop Drawings.
 4. Sod: Time delivery so that sod will be placed within 24 hours after stripping. Comply with requirements of TPI for harvesting, delivery, storage and handling of sod.
 5. Sprigs: Time delivery so that sprigs are planted within 24 hours after being harvested.
 6. Inspect lawn and meadow materials upon arrival at Site. Immediately and permanently remove unacceptable materials from Site.
- B. Storage of Materials:
1. Store and cover materials to prevent deterioration. Remove packaged materials that become wet or show deterioration or water marks from the Site.
 2. Seed that becomes wet, moldy or damaged during the time of storage on-Site or that has been damaged during transit is not acceptable.
 3. Protect sod against drying and breaking of rolled strips.
 4. If sod is stacked, place roots to roots or grass to grass.
 5. Protect sod from exposure to wind and sun and from freezing.
- C. Handling of Materials: Do not dump sod from vehicles.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements:
1. Proceed with and complete lawn and meadow planting as rapidly as portions of the Site become available, working within the seasonal limitations for each type of lawn, grass and wildflower planting required.
 2. Proceed with planting only when current and forecasted weather conditions are favorable to successful planting and establishment of lawns and meadows.
 - a. Do not spread seed when wind velocity exceeds five miles per hour.
 - b. Do not plant when drought, or excessive moisture, or other unsatisfactory conditions prevail.
 3. Herbicides, chemicals and insecticides shall not be used on areas bordering wetlands.
- B. Scheduling:
1. Coordinate planting with specified extended service periods to provide required service from date of Substantial Completion. Plant during one of the following periods:
 - a. Spring Planting: March 15 to June 1.
 - b. Fall Planting: September 1 to October 30.
 2. Do not begin lawn and meadow planting until water, acceptable for use and adequate in supply, is available on-Site and can be successfully transported to the areas of Work. Coordinate provision of adequate and acceptable water supply with Project Schedule.

3. Do not proceed with installation of loam until all subgrade utility services have been installed, are operating successfully and have been approved by ENGINEER.
- C. Pre-installation Conference:
1. Prior to commencement of lawn and meadow planting and associated Work, CONTRACTOR shall schedule and meet at the Site with the landscape installer, the installers of other Work in and around lawn and meadow areas that follows the lawn and meadow Work; and ENGINEER and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the lawn and meadow Work, including the following:
 - a. Review Project requirements and the Contract Documents.
 - b. Review required submittals, both completed and yet to be completed.
 - c. Review availability of water and methods of delivery.
 - d. Review status of below-grade work and required access during lawn and meadow planting and establishment.
 - e. Review Project Schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
 - f. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
 - g. Review procedures required for protection of lawns and meadows during the remainder of the construction period.
 - h. Review required inspection, testing, and certifying procedures.
 2. Record the discussions of the Pre-installation Conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
 3. Record all revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.
 4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.8 WARRANTY

- A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.
- B. Special Warranties: Warranty lawns and meadows through the specified extended service period.

1.9 EXTENDED SERVICE

- A. Extended Lawn Service:
1. Begin extended service immediately after each lawn area is acceptably established. Provide extended service for not less than the following periods:
 2. Seeded Lawns: Sixty days from date after lawn areas are acceptably established.

- a. When full service period has not elapsed before end of planting season, or if lawn is not acceptably established, continue service during next planting season.
3. Service lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
4. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources. Keep newly germinated plants uniformly moist to a depth of 4-inches, applied at a minimum rate of 1-inch per week, or greater as required to maintain minimum moisture depth specified. Provide and maintain watering gages and soil moisture probes until end of maintenance period.
 - a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - b. After plants have their first true leaves and grasses show mature blades, watering shall be performed to provide moisture to a depth of 6-inches, and not performed again until top 1-inch of loam has dried.
 - c. During first week, water sod daily or more frequently as necessary to maintain moist loam to a minimum depth of 4-inches below bottom of sod blanket.
5. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass-leaf height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowing to maintain the following grass height:
 - a. Mow grass 2 to 3-inches high.
6. Lawn Fertilization: Apply fertilizer after initial mowing and when grass is dry.
 - a. Use fertilizer that will provide actual nitrogen of at least one pound for each 1000 square feet of lawn area.
7. After seed has passed its expected germination period, reseed all areas and parts of areas that fail to show a uniform stand of grass. Reseed repeatedly until all areas are covered with grass.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Turf grass Sod:
 1. Certified Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes and insects, complying with TPI specifications and guidelines.
 2. Provide strongly rooted machine-cut sod, not less than two years old of uniform density, color and texture. Provide only sod capable of vigorous growth and development when planted (viable, not dormant) and in strips not more than 18-inches wide by 14 feet-0 inches long by 3/4-inch thick (excluding top growth and thatch). Provide sod composed principally of the following:
 - a. Bermuda grass (*Cynodon dactylon*).

- B. Fertilizers:
 - 1. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - a. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports.
- C. Accessories:
 - 1. Provide herbicides, chemicals and insecticides as needed for disease, fungus or pest control. All herbicides, chemicals and insecticides shall be bear approval labels indicating they are approved by the United States Department of Agriculture for the intended uses and application rates.
 - 2. Post Emergent Crab Grass and Plantain Chemical: Provide recommended post emergent crab grass and plantain control throughout the maintenance period to ensure germinated and established lawns free of crab grass and other undesirable grasses and forbs.

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Excavate or fill subgrade, as required, to bring subgrade to elevations shown. Maintain all angles of repose. Confirm that subgrade is at proper elevations and that no further earthwork is required to bring the subgrade to proper elevations. Provide subgrade elevations that slope parallel to finished grade and towards subsurface drains shown.
- F. Remove all construction debris, trash, rubble and all extraneous materials from subgrade. In the event that fuels, oils, concrete washout or other material harmful to plant growth or germination have been spilled into the subgrade, excavate the subgrade sufficiently to remove all such harmful materials and fill with approved fill, compacted to the required subgrade compaction level.

3.3 FINE GRADING

- A. Spread fertilizer and work lightly into the top 4-inches of site topsoil by harrowing or tilling prior sodding.
- B. Grade planting areas to smooth, even surface with loose, uniformly fine texture. Remove all stones and extraneous material in excess of 1-inch diameter. Roll, rake and remove ridges and fill depressions, as required to meet finish grades.
- C. Moisten prepared areas before sodding. Water thoroughly and allow surface moisture to dry before planting. Do not create a muddy loam condition.

3.4 SODDING LAWNS

- A. Do not lay sod on ground that is frozen, dust dry or that has not been uniformly prepared, as specified. Do not lay dormant sod.
 - 1. Lay sod within 24 hours of harvesting.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod.
 - 1. Place sod strips in straight lines parallel to one another.
 - 2. Lay sod across angle of slopes exceeding one on three.
 - 3. Anchor sod with wooden pegs, or steel staples, on slopes exceeding one on six, spaced as recommended by sod supplier, but not less than two anchors for each sod strip to prevent slippage.
- C. Immediately upon completion of a section of sodding, tamp, roll lightly and water, to ensure contact with subgrade and elimination of air pockets.
- D. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass.
- E. Immediately after planting, water sod thoroughly with a fine spray. Water sufficiently to ensure penetration of moisture to bottom of prepared loam layer, not just to bottom of sod blanket.

3.5 RECONDITIONING EXISTING LAWNS AND MEADOWS

- A. Recondition existing lawn and meadow damaged by CONTRACTOR'S operations, including areas used for storage of materials or equipment and areas damaged by movement of vehicles. Recondition existing lawns and meadow areas where minor regrading is required.
- B. Provide fertilizer, seed or sod and soil amendments, as specified for new lawn and meadow, and as required to provide satisfactorily reconditioned lawns and meadows. Provide new loam as required to fill low spots and meet new finish grades.
- C. Remove diseased or unsatisfactory lawn and meadow areas; do not bury into soil. Remove topsoil containing extraneous materials resulting from CONTRACTOR'S operations including oil drippings, stone, gravel and other construction materials.

- D. In areas approved by ENGINEER, where substantial lawns and meadows remain (but are thin), mow, dethatch, core aerate and rake. Fill low spots, remove humps, cultivate soil, fertilize, and seed. Remove weeds before seeding or if extensive, apply selective chemical weed killers, as required. Apply a seedbed mulch, if required, to maintain moist condition.
- E. Water newly planted areas and keep moist until new lawns and meadows are established, as specified.

3.6 ACCEPTANCE CRITERIA FOR LAWNS AND MEADOWS

- A. Lawn and meadow Work will be considered acceptable when:
 - 1. Sodded Lawn: When a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

3.7 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris, created by lawn and meadow Work, from paved areas. Clean wheels of vehicles before leaving Site to avoid tracking soil and loam onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout extended service period and remove when service period ends. Treat, repair or replace damaged lawns and meadows.
- C. Remove erosion-control measures after lawn and meadow extended service period ends.

3.8 INSPECTION AND ACCEPTANCE

- A. Where lawns and meadows do not comply with specified acceptance criteria, reestablish lawns and meadows and continue extended service period until lawns and meadows comply with criteria for acceptance.

+ + END OF SECTION + +

SECTION 33 01 30.82

EPOXY LINING FOR CONCRRETE MANHOLES

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

- A. This section defines the scope of work of the specification which includes executing surface preparation, cleaning, application of specified products, inspection and testing for general repairs and lining of newly installed, existing, and defective specified structures and surfaces by a monolithic application of a high build, 100% solids, structural epoxy system to seal infiltration/exfiltration, repair voids and deterioration, and provide enhanced corrosion protection as a total rehabilitative lining system.
- B. Procedures for qualifying and are described herein. In addition to the lining system, different repair methods and procedures are listed in this specification. All structures scheduled for rehabilitation shall be cleaned, prepared, repaired, patched and/or sealed as required prior to the application of the structural epoxy system.

1.2 SCOPE OF WORK

- A. The Contactor shall be responsible for furnishing all labor, supervision, products, materials, and equipment required to complete all rehabilitation work and testing in accordance with this Specification.
- B. All Sections of this Specification are mutually complimentary, and the overall intent is that the Contractor shall provide for everything in his portion of the work required to make a complete and operable job in every respect unless specifically noted otherwise.
- C. It is the intent of this Specification to ensure that the work, as completed shall meet all applicable codes, ordinances, rules and regulations of every authority having jurisdiction in the area where the project(s) is located. Failure of the Contractor to point out items that do not meet such requirements does not relieve the Contractor or the Subcontractors of the responsibility of meeting them.
- D. All supplies shall be stored and maintained by the Contractor in accordance with manufacturer's recommendations. Materials shall not be exposed to adverse conditions prior to the work. All materials shall be kept in secured area and away from general public access. The Contractor shall review and maintain all Safety Data Sheets (SDS), product labeling, and technical literature at the project site.

1.3 REFERENCES

- A. The latest codes and standards referenced herein and belonging to the following organizations shall be followed:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. National Association of Corrosion Engineers, NACE International (NACE)
 - 3. The Society for Protective Coatings (SSPC)
 - 4. Occupational Safety and Health Administration (OSHA)
 - 5. Resource Conservation and Recovery Act (RCRA)
 - 6. United States Environmental Protection Agency (EPA)
 - 7. Environmental Technology Verification (ETV)

8. International Concrete Repair Institute (ICRI)
9. National Association of Sewer Service Companies (NASSCO)
10. National Sanitation Foundation (NSF)
11. Center for Innovative Grouting Materials and Technology (CIGMAT)
12. American Association of State Highway and Transportation Officials (AASHTO)

PART 2 – PRODUCTS

2.1 ACTIVE LEAK CONTROL

- A. Active leak control materials are to be utilized to stop running water, infiltration, and other water stop needs.
- B. All active leak control materials must be compatible with repair and lining materials.
- C. Active leak control materials
 1. Hydraulic cement
 - a. Quick setting, hydraulic cement compound designed for minor patching, and as a leak stopper and water plug, which stops running water and/or seepage through concrete.
 - b. Specified material(s) are listed below:
Epoxytec Mortartec (#RCM01,02, RCME1, RCHY) by Tnemec Epoxytec (epoxytec.com)
Local Representative Agency: FloridaProtectiveCoatings@Tnemec.com
Local Representative: Chad Holmes, CHolmes@tnemec.com, (727)201-6706
 2. Chemical grout
 - a. Chemical grout material used for grouting active leaks shall be injection hydrophobic polyurethane or equal.
 - b. While being injected, the chemical sealant must be able to react/perform in the presence of water.
 - c. The cured material must withstand submergence in water, without degradation.
 - d. The resultant sealant (grout) formation must be impervious to water penetration.
 - e. The final sealant must withstand freeze-thaw and wet-dry cycles without causing adverse changes to the sealant.
 - f. The final sealant formation must not be biodegradable.
 - g. Chemical grouting material final cure must not exceed one (1) hour.
 - h. Chemical grouting material must be compatible to other specified top coating and repair material and the final topcoat of the structural epoxy system.

2.2 CONCRETE REPAIR

- A. Concrete repair methods include isolated, sectional, and fully restorative methods including brick, concrete, and other masonry filling, patching, termination of materials, seams, anchors, and rebuilding based on various conditions in order to repair imperfections that adversely affects flow, would compromise the structure and liner in the future, and to restore the structure to a profile accepting to the lining system.
- B. Concrete patching and rebuilding

1. Concrete patching repair shall be performed for any spot repairs, filling or repairs of deep spalls, voids, gaps, bugholes/holes, and/or crevasses.
2. Rebuild isolated structures, inverts, benches and/or troughs, or other flow structures requiring build-up and/or rebuild in order to provide smooth flow transition waterway with no distortion of flow or connections.
3. Materials
 - i. The material is early-high strength, high build, sewer grade silica fume, fiber reinforced, industrial-grade modified mortar:
 - ii. Specified material(s) are listed below:

Epoxytec Mortartec (#RCM01,02, RCME1, RCHY) by Tnemec Epoxytec (epoxytec.com)

Local Representative Agency: FloridaProtectiveCoatings@Tnemec.com

Local Representative: Chad Holmes, CHolmes@tnemec.com, (727)201-6706

C. Resurfacing

1. Concrete repair methods may also include resurfacing the substrate to create uniformity of the surface to accept coatings and to restore the substrate's profile. This will be required for any newly installed concrete structures to reduce the occurrences of outgassing, and for existing structures where degradation to substrate profile is greater than an ICRI CSP-6, and/or when the substrate requires restoration bringing profile to near-original.
2. Resurfacing thicknesses for existing structures, the thickness shall range between 1/4 inch and 1/2 inch (1/4" – 1/2"). For newly installed concrete structures, thicknesses shall be between 1/16 inch to 1/8 inch (1/16" – 1/8"). Should the substrate and structure require repair beyond half-inch, refer to "Concrete repair" for repairing materials beyond half-inch (1/2") thickness.
3. Materials
 - i. The material is a fiber-reinforced, high build, corrosion resistant epoxy-modified-mortar, fortified with silica fume and micro silica. The hardened epoxy binder is dense and highly impermeable. The above performance is achieved by a complex formulation of mineral, organic resin and densifying agents and sophisticated chemical additives combined with next generation water-borne epoxy curing agents. Graded quartz sands are used to enhance particle packing and further improve the fluidity and hardened density. The composition also possesses excellent thin-section toughness, high modulus of elasticity and is self-bonding
 - ii. The epoxy-modified-mortar shall exhibit excellent thin-section toughness and applied as low as 1/16 inch thickness, and capable of build-up up to 1-inch.
 - iii. The epoxy-modified-mortar must be designed to accept the top coat structural epoxy at a minimum of two (2) hours after application at 77F.
 - iv. The epoxy-modified-mortar can be applied by hand and/or wet-shot spray applied.
 - v. The epoxy-modified-mortar shall not require any further preparation or conditioning within 36 hours (at 77F) to accept structural epoxy top coat applications.

- vi. Specified material(s) are listed below:
Epoxytec Mortartec (#RCM01,02, RCME1, RCHY) by Tnemec Epoxytec (epoxytec.com)
Local Representative Agency: FloridaProtectiveCoatings@Tnemec.com
Local Representative: Chad Holmes, CHolmes@tnemec.com, (727)201-6706

D. Exposed reinforcing bars

- 1. Exposed reinforcing bars must be treated with rust inhibiting primer, and encapsulated/patched with high density mortar.
- 2. Materials
 - i. Rust inhibiting primer must be epoxy-based, rust inhibiting primer designed for rapid curing, and for steel applications.
 - ii. High density mortar patching will consist of any of the specified repair mortars within this section. Refer to "Concrete repair" for repairing materials.
 - iii. Specified material(s) are listed below:
Epoxytec Mortartec (#RCM01,02, RCME1, RCHY) by Tnemec Epoxytec (epoxytec.com)
Local Representative Agency: FloridaProtectiveCoatings@Tnemec.com
Local Representative: Chad Holmes, CHolmes@tnemec.com, (727)201-6706

2.3 LINING

A. General

- 1. It is the intent of this section to provide for the waterproofing, sealing, structural reinforcement and corrosion protection of manholes and similar underground structures by the safe, quick and economical application of an ultra-high build 100% solids structural epoxy liner.
- 2. This specification establishes the minimum standard for material and method of application for the structural reinforcement, sealing and corrosion protection of leaking and deteriorated manholes by lining with a 100% solids, high build structural grade epoxy. The structural epoxy liner shall be installed at a minimum thickness of 125 mils DFT (0.125").
- 3. The structural epoxy lining system will be used on surfaces in order to protect against corrosion and seal from I&I.

B. Materials

- 1. Specified material(s) are listed below:

Epoxytec Mortartec (#RCM01,02, RCME1, RCHY) by Tnemec Epoxytec (epoxytec.com)
Local Representative Agency: FloridaProtectiveCoatings@Tnemec.com
Local Representative: Chad Holmes, CHolmes@tnemec.com, (727)201-6706

PART 3 - EXECUTION

3.1 GENERAL

- A. All work shall be in strict accordance with the specifications and recommendation including application of all products as required and in accordance with manufacturer's directions.

- B. Contractor shall conform to all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
- C. Products are to be kept dry, in a climate controlled environment, protected from weather and stored under cover. Products are to be stored and handled according to their safety data sheets. When freezing temperatures are expected in the area, the Contractor shall take measures to keep applied materials warm (as per manufacturer's guidelines) and provide the required heat in the structure before repair work is started.
- D. Any invert(s), channels, drains, or other openings shall be covered during construction operations to prevent loose materials from collection.
- E. Bypassing and/or blocking of flow shall be done only with prior approval of the Owner. Contractor shall be responsible for transporting or pumping water to maintain operation of any flow, treatment, collection or distribution system while repairs or lining to structures are made.
- F. The Owner shall supply water necessary for the project to the Contractor at no cost, from locations indicated by Owner prior to the start of the project. Contractor shall be responsible for transporting the water.
- G. It shall be the contractor's responsibility to provide traffic control required by the particular location and/or jurisdiction.
- H. Use approved equipment designed, recommended and/or manufactured by the material supplier specifically for the application of all materials.
- I. Applicator shall initiate and enforce quality control procedures consistent with applicable ICRI, NACE, and/or SSPC standards and the repair/coating manufacturer's recommendations.
- J. Examination
 - 1. Examine surface to receive rehabilitation prior to applying any materials. Notify Owners in writing if surfaces are not acceptable for rehabilitation and/or lining.
 - 2. All structures to be repaired and coated shall be readily accessible to the Applicator.
 - 3. Any active flows shall be dammed, plugged or bypassed as required to ensure that the liquid flow is maintained below the surfaces to be coated and that concrete to be coated has not reached moisture levels surpassing 90%. Flows should be totally plugged and/or diverted when coating any invert. All extraneous flows into the structures at or above the area coated shall be plugged and/or diverted until the structural epoxy coating has set hard to the touch.
 - 4. Temperature of the surface to be coated must be maintained between 65F and 110F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Specified surfaces should be shielded to avoid exposure of direct sunlight or other intense heat source. Where varying surface temperatures do exist, coating installation should be scheduled when the temperature is falling versus rising.
 - 5. New Portland cement concrete structures shall have endured a minimum of 28 days since installation, prior to commencing epoxy structural coating installation.
 - 6. Prior to commencing surface preparation, Contractor shall inspect all surfaces specified to receive the coating and notify Owner, of any noticeable disparity in the site, structure or surfaces which may

interfere with the work, use of materials or procedures as specified herein.

3.2 CLEANING AND PREPARATION OF SUBSTRATE

- A. Surface preparation must be achieved immediately prior to utilizing any repair material and/or coatings; re-inspection and/or subsequent surface preparation may need to be repeated should conditions change after initial preparation.
- B. All receiving surfaces shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, grease, sludge and all debris or material that may be attached to the substrate.
- C. Surface preparation shall be performed on all specified surfaces to be lined or rehabilitated. Unless otherwise noted, all newly installed concrete structures should first undergo curing of minimum 28 days prior to surface preparation and rehab/lining execution.
- D. The objective of surface preparation is to produce a surface that is suitable for application and adhesion of the specified protective coating system and repair products.
 - 1. Protrusions such as from burrs, sharp edges, fins, and concrete spatter shall be removed during surface preparation.
 - 2. Voids and other defects that are at or near the surface shall be exposed during surface preparation.
 - 3. All concrete that is not sound shall be removed so that only sound concrete remains.
- E. Surface preparation must achieve a clean and sound substrate in accordance with SSPC-SP13/NACE No. 6 "Surface Preparation of Concrete."
 - 1. High pressure water cleaning or water jetting, and/or pre-approved dry or wet abrasive blasting may be necessary in order to achieve acceptable surface preparation free of all foreign material, laitance, oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, and/or other contaminants.
 - 2. An ICRI profile of CSP 5 or higher shall be achieved.
 - 3. For existing structures, surface preparation shall yield an acceptable pH requirement.
 - 4. No surface water or active leaks are to be present. Prepared concrete surfaces shall be tested for residual moisture after cleaning and drying, and prior to the application of the coating. Drying may be required with forced air and/or dry heat to achieve moisture levels below 80% prior to coating.
 - 5. When grease and oil are present within the structure, an approved detergent or degreaser may be used integrally with the high pressure cleaning water if conditions dictate.
- F. All materials resulting from the cleaning shall be caught at the base of each structure and removed prior to applying specified products.
- G. All loose or defective concrete, mortar, brick, grout, ledges, steps and protruding ledges shall be removed to provide an accessible and uniformed surface prior to application of materials.

3.3 ACTIVE LEAK CONTROL PROCEDURE

- A. Execution
 - 1. When leaks are not readily identifiable upon cleaning operation, use blowers to dry interior for positive identification of leaks and weeping areas.

2. Hydraulic cement
 - i. The work consists of hand applying a dry quick-setting cementitious mix designed to instantly stop running water or seepage in all types of concrete and concrete structures. The certified applicator shall apply material in accordance with manufacturers' recommendations.
 - ii. The area to be repaired must be clean and free of all debris.
 - iii. Proper applications should not require any special mixing of product or special curing requirements after application.
3. Chemical grout
 - i. Application of materials shall be by injection method only.
 - ii. Mixing and handling of all the chemical grout materials shall be in strict accordance with manufacturer's recommendations.
 - iii. All excess chemical grout must be removed from the surface via mechanical grinding means and top patched with Hydraulic cement.

3.4 CONCRETE REPAIR METHODS

- A. All loose, cracked and corroded materials shall be removed from the area, exposing a sound substrate.
- B. The materials shall be formed, trowel-applied, or shotcrete sprayed utilizing proper equipment on to specified surfaces. Follow instructions as published by the material manufacturer. If spraying, consult manufacturer for proper instruction and material version.
- C. Concrete patching and rebuilding
 1. Execution
 - i. Once cured, and before applying any lining system materials, refer to material specifications for post-cure preparation and readiness instructions. Follow mixing, application and handling instructions as written per materials product technical data sheets and SDS.
 - ii. Apply materials and allow proper curing times prior to coating/lining.
- D. Resurfacing
 1. Execution
 - i. Follow mixing, application and handling instructions as written per materials product technical data sheets and SDS.
 - ii. The mortar kits come pre-proportioned, for hand applications- use full kits as supplied, no do not any extra water.
 - iii. For spray applications, water may be added, but limited, as specified by the Manufacturer.
 - iv. When mixed, a paste-like material will develop which may be troweled, sprayed, cast, pumped or gravity-flowed applied.
 - v. This mortar will harden quickly without any need for special curing. Therefore, execute finishing work by trowel immediately after applying or disbursing onto the substrate.
 - vi. Either commence spraying or hand applying.
 - vii. The epoxy-modified-mortar shall be applied at a 1/4 inch minimum, and 1/2 inch maximum (1/4" – 1/2") for existing infrastructure. And between 1/16 inch and 1/8 inch (1/16" – 1/8") for newly installed structures.
 - viii. Finish with trowel.
 - ix. Allow at least two (2) hours (77F) to cure, minimum, before applying the specified structural epoxy coating, but do not exceed thirty-six (36) hours. The window and condition to apply the structural epoxy coating remains open for 36 hours. Should this window expire,

consult with manufacturer for written and approved guidance and instruction.

E. Exposed reinforcing bars

1. Execution

- i. Prepare and clean via SSPC-SP 11 exposed reinforcing bars then clean with solvent (SSPC SP-1).
- ii. Treat with an epoxy-based, rapid-setting, rust inhibiting primer.
- iii. Allow primer to cure.
- iv. Patch with concrete patching materials as specified in "Concrete patching and rebuilding" section. Follow product and manufacturer execution specifications accordingly.

3.5 LINING METHOD AND PROCEDURE

A. Execution

1. Application procedures shall conform to the recommendations of the structural epoxy coating manufacturer, including material handling, mixing, safety, and application equipment.
2. Top coating or additional coats of the structural epoxy coating should occur as soon as the prior coat becomes tack free, but no later than the recoat window for the specified material(s). Additional surface preparation procedures will be required if this recoat window is exceeded.
3. Follow all published and manufacturer recommended application methods.
4. If spraying, the Contractor must be certified to spray by the coating manufacturer verifying training and that the spray equipment is approved by the coating manufacturer, specifically designed to accurately ratio and condition the specified structural epoxy coating materials. Refer to the manufacturers' spray instruction and procedure prior to procuring material and applying any material in order to receive proper material variations and application considerations.
 - i. Apply at a minimum thickness of 125 mils DFT (0.125 inches).
5. If trowel-applied, properly mix and apply materials to all specified surfaces by hand-applied methods with trowel or trowel-type tools.
 - i. Combine 2 gallons kits, Part B to Part A of the packaged material, mix with a low-speed drill mixer for five (5) minutes until a homogenous blend is achieved.
 - ii. Trowel the surface or section: for finishing, allow product to start initial gel (circa 30 minutes at 77F) and rub down with water to create a smooth, uniform finish.
 - iii. Apply at a minimum thickness of 125 mils DFT (0.125 inches).
6. Allow 24 hours to cure.

3.6 INSTALLATION OF CHIMNEY SEAL

A. Execution

1. On the metal surfaces, prepare surface to a SSPC-SP10 or 11 standard so that the preparation removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter by power wire brushing, power sanding, power grinding, power tool chipping, and power tool descaling.
 - i. After preparation, clean with SSPC-SP1 "Solvent Cleaning" method to remove dust and debris.
 - ii. Allow solvent or cleaner to dry out.
 - iii. Apply one coat of epoxy primer.

1. Primer shall be applied as directed on manufacturer published data sheets at 2-3 mils WTF.
2. Allow primer to cure until it is tack-free. This time depends on conditions; blowing forced air will assist the cure time.
2. To prepare other substrates, refer to concrete preparation sections of this specification as described for cementitious/brick/or mortar substrates. Should you have to prepare installed liner, solvent rub and wire brush to create scored abrasion prior to top coating with polymer elastomer.
3. Once the primer is tack-free, apply polymer elastomer as directed on manufacturer published data sheets at 125 mils (1/8") DFT for peak to valley.

3.7 QUALITY ASSURANCE AND ACCEPTANCE

- A. Surface preparation inspection must take place prior to proceeding to material applications, this applies to both repair and lining applications.
 1. Applicator must record, and submit to coating manufacturer's representative or designated inspector:
 - i. pH level
 - ii. Moisture content
 - iii. Abrasive media type and/or preparation methods
 - iv. ICRI conditions
- B. During application, Applicator shall regularly perform and record epoxy coating thickness readings with a wet film thickness gage, such as those meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages or other type of measuring probe or similar, to ensure uniform thickness during application
- C. Applicator shall perform holiday detection on all surfaces coated with the epoxy coating in the presence of the coating manufacturer's representative or designated inspector. After the epoxy coating has set hard to the touch, surfaces shall first be dried, an induced holiday shall then be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99).
 1. All detected holidays shall be marked by the designated inspector and repaired. Additional epoxy coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer's recommendations.
- D. A final visual inspection shall be made by the Applicator and the coating manufacturer's representative or designated inspector. Any deficiencies in the finished coating shall be marked and repaired by Applicator according to the procedures set forth herein.

++END OF SECTION++

SECTION 33 05 05

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
 - a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections.
 - b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
 - c. Work on or affecting existing buried piping.
 - d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
 - e. Supports, restraints, and thrust blocks.
 - f. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 40 05 05, Exposed Piping Installation.
 - g. Field quality control, including testing.
 - h. Cleaning and disinfecting.
 - i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
2. Coordinate with appropriate piping Sections of Division 40, Process Integration.

C. Related Sections:

1. Section 31 23 05, Excavation and Fill.
2. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ASME Boiler and Pressure Vessel Code.
2. ASME B31.3, Process Piping.
3. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
4. ASTM B32, Specification for Solder Metal.

5. ASTM C12, Practice for Installing Vitrified Clay Pipe Lines.
6. ASTM C425, Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
7. ASTM C828, Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.
8. ASTM C924, Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Test Method.
9. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
10. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
11. ASTM D4174, Practice for Cleaning, Flushing and Purification of Petroleum Fluid Hydraulic Systems.
12. ASTM F1417, Test Method for Installation Acceptance of Plastic Gravity Sewer Lines using Low-Pressure Air.
13. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.
14. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
15. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
16. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
17. ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
18. ANSI/AWWA C603, Installation of Asbestos-Cement Pressure Pipe.
19. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
20. ANSI/AWWA C606, Grooved and Shouldered Joints.
21. ANSI/AWWA C651, Disinfecting Water Mains.
22. AWWA M9, Concrete Pressure Pipe.
23. AWWA M11, Steel Water Pipe - A Guide for Design and Installation.
24. AWWA M23, PVC Pipe - Design and Installation.
25. AWWA M41, Ductile-Iron Pipe and Fittings.
26. AWWA M45, Fiberglass Pipe Design.
27. AWWA M55, PE Pipe - Design and Installation.
28. ASCE 37, Design and Construction of Sanitary and Storm Sewers.
29. American Concrete Pipe Association, Concrete Pipe Handbook.
30. Chlorine Institute, Inc., Piping Systems for Dry Chlorine, Pamphlet No. 6.
31. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including.
 - a. Sarasota County Utilities.
 - b. Florida Department of Environmental Protection (FDEP).
 - c. Florida Department of Transportation (FDOT).
 2. Obtain required permits for Work in roads, rights-of-way, railroads, and other areas of the Work.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Laying schedules for concrete pipe and piping with restrained joints.
 - b. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
 - 2. Product Data:
 - a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
 - 3. Testing Procedures:
 - a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER's approval prior to commencing testing.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
 - 2. Field Quality Control Submittals:
 - a. Results of each specified field quality control test.
- C. Closeout Submittals: Submit the following:
 - 1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
 - b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
 - c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.
 - d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.
- B. Storage:
 - 1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
 - 2. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. Cover PVC and CPVC pipe and fittings stored outdoors.

C. Handling:

1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free from dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 40, Process Integration.

B. General:

1. Pipe Markings:
 - a. Factory-mark each length of pipe and each fitting with designation conforming to those on approved laying schedules.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

C. Cathodic Protection:

1. Bonding Cables: Bonding cable and test lead wires shall be not less than No. 6 AWG, Type CP copper cathodic protection cable, with low density, high molecular weight polyethylene insulation.
2. Test Lead Stations: Provide test lead stations where shown and indicated in the Contract Documents. Standard connection boxes for test lead stations shall be plastic terminal boxes, 18 inches long and five-inch inside diameter, with locking cast iron lid with "CP TEST" cast into cover. Inside terminal box shall be terminal block with seven terminals. Terminal box shall be manufactured by C.P. Test Services "NM-7" or equal.

2.2 BURIED PIPING IDENTIFICATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 91 00, Painting.
3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation
 - b. Seton Identification Products

- c. Marking Services, Inc.
 - d. Or equal.
- B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
 - 1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
 - 2. Message shall read, "CAUTION ., SANITARY SEWER, PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 91 00, Painting.
 - 3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation
 - b. Seton Identification Products
 - c. Marking Services, Inc.
 - d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
 - 2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from ENGINEER before proceeding.
 - 3. ENGINEER will observe excavations and bedding prior to laying pipe by CONTRACTOR. Notify ENGINEER in advance of excavating, bedding, pipe laying, and backfilling operations.
 - 4. Minimum cover over buried piping shall be 3 feet, unless otherwise shown or approved by ENGINEER.
 - 5. Earthwork is specified in Section 31 23 05, Excavation and Fill.
 - 6. Excavation in excess of that required or shown, and that is not authorized by ENGINEER shall be filled at CONTRACTOR's expense with granular material furnished, placed, and compacted as specified.
 - 7. Comply with NFPA 24 for "Outside Protection", where applicable to water piping systems used for fire protection.
- B. Separation of Sewers and Potable Water Piping:
 - 1. Horizontal Separation:
 - a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
 - b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 18 inches above top of sewer.
 - c. Exception:
 - 1) Where it is not possible to provide minimum horizontal separation described above, construct potable water main of cement-lined

ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.

2. Vertical Separation:

- a. Provide minimum vertical distance of 18 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.
- b. Center a section of potable water main pipe at least 17.5 feet long over sewer so that sewer joints are equidistant from potable water main joints.
- c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.
- d. Exceptions:
 - 1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
 - 2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

C. Plugs:

1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to ENGINEER.

D. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.

1. Trench excavation and backfill, and bedding materials shall conform to Section 31 23 05, Excavation and Fill, as applicable.
2. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal diameter, and minimum of six inches of granular bedding material underneath pipes four-inch nominal diameter and larger.
3. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
4. Carefully and thoroughly compact pipe bedding with handheld pneumatic compactors.

5. Do not lay pipe until ENGINEER approves bedding condition.
6. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

E. Laying Pipe:

1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
 - b. Thermoplastic Pipe: ASTM D2321, ASTM D2774, ANSI/AWWA C605, AWWA M23, AWWA M45, AWWA, M55.
 - c. Sanitary and Storm Sewers: ASCE 37.
2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by ENGINEER. Remove and reinstall pipes that are not installed correctly.
3. Slope piping uniformly between elevations shown.
4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by ENGINEER.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by ENGINEER.
7. Place concrete pipe containing elliptical reinforcement with minor axis of reinforcement in vertical position.
8. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
9. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by ENGINEER.
10. For PVC and CPVC piping with solvent welded joints, 2.5-inch diameter and smaller, and copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
11. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
12. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
13. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
14. Do not place blocking under pipe, unless specifically approved by ENGINEER for special conditions.
15. Touch up protective coatings in manner satisfactory to ENGINEER prior to backfilling.
16. Notify ENGINEER in advance of backfilling operations.

17. On steep slopes, take measures acceptable to ENGINEER to prevent movement of pipe during installation.
18. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
19. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

F. Jointing Pipe:

1. Ductile Iron Mechanical Joint Pipe:

- a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
- b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
- c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
- d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
- e. Push gland toward socket and center gland around pipe with gland lip against gasket.
- f. Insert bolts and hand-tighten nuts.
- g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

- h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.
 - i. Restrained mechanical joints shall be in accordance with Section 40 05 19, Ductile Iron Process Pipe.
2. Ductile Iron Push-On Joint Pipe:
- a. Prior to assembling joints, thoroughly clean with wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.
 - b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
 - c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.
 - d. Immediately prior to joint assembly, apply thin film of pipe manufacturer's recommended lubricant to surface of gasket that will

- come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.
- e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.
 - f. Maintain an adequate supply of gaskets and joint lubricant at the Site when pipe jointing operations are in progress.
3. Ductile Iron Proprietary Joints:
- a. Install pipe that utilizes proprietary joints for restraint specified in Section 40 05 19, Ductile Iron Process Pipe, or other such joints, in accordance with manufacturer's instructions.
4. Ductile Iron Flanged Joints:
- a. Assemble flanged joints using ring-type gaskets, thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised face flanges. Use full face gaskets for flat face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for service intended in accordance with manufacturer's ratings and instructions. Gaskets shall be properly centered.
 - b. Bolts shall be tightened as recommended by the manufacturer in sequence that ensures equal distribution of bolt loads.
 - c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch when fully tightened. Bolts shall not fall short of the nut when fully taken up. Ends of bolts shall be machine cut and neatly rounded. Do not use washers.
 - d. Prior to assembly, lubricate bolt threads and gasket faces.
 - e. After assembly, coat all bolts and nuts, except those of stainless steel, with two coats, minimum dry film thickness of eight mils each, of high-build epoxy or bituminous coating manufactured by Tnemec, or equal.
5. Mechanical Coupling Joints:
- a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings specified.
 - b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with wire brush to remove foreign matter.
 - c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet

- metal to metal, joint is complete and further tightening is not required.
- d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove clamps from coupling. Slide coupling over plain ends of pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with torque wrench to torque recommended by manufacturer.
6. HDPE Pipe Joints:
- a. Bell and Spigot Joints:
 - 1) Remove all burrs and provide reference mark at correct distance from pipe end. Place mark such that no more than 1/2-inch of machined spigot surface will be visible outside of bell after pipe has been joined.
 - 2) Clean spigot end and bell thoroughly with soap and water before positioning gasket.
 - 3) Lubricate spigot groove with manufacturer's recommended lubricant. Thoroughly clean gasket and place in spigot groove starting at bottom, ensuring that gasket fins face backwards toward pipe.
 - 4) Thoroughly lubricate gasket with pipe manufacturer's recommended lubricant and equalize stretch in gasket by running screwdriver under gasket around its entire circumference three times. Reposition gasket in groove after stretching.
 - 5) Thoroughly clean and lubricate receiving bell. Align pipe as straight as possible and insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.
 - 6) If mechanical means are used to insert spigot end, protect with wood the end of pipe being pushed, to ensure even distribution of pressure.
 - b. Butt Fusion Welded Joints:
 - 1) Install joints in accordance with manufacturer's instructions using hydraulic butt fusion machine or manual machine equipped with torque wrench. Equipment shall be able to achieve and maintain heating tool temperature range of 400 to 450 degrees F and an interface pressure of 60 to 90 psi.
 - 2) Clean interior and exterior of pipe and fitting ends with clean, dry, lint-free cloth.
 - 3) Align ends to be joined in the fusion machine without forcing ends into alignment. Adjust alignment as necessary and tighten clamps to prevent slippage.
 - 4) Place facing tool between ends to be joined and face them to provide clean, smooth, parallel mating surface. If stops are present, face ends down to the stops. Remove all shavings after facing without touching ends.
 - 5) Re-check alignment of ends and check for slippage against fusion pressure. There shall be no detectable gaps between ends. Align outside diameters.
 - 6) Heating tool shall maintain pipe manufacture's recommended temperature range. Place the tool between ends to be joined. Move ends against heating tool to achieve full contact. Hold ends against heating tool without force until the following melt bead size is formed:

Pipe Diameter (inches)	Required Melt Bead Size (inches)
2 to 4	1/8 to 3/16
4 to 12	3/16 to 1/4
12 to 24	1/4 to 7/16
24 to 54	7/16 to 9/16

7) Upon forming proper melt bead size, quickly separate ends and remove heating tool. Quickly inspect melted ends and bring ends together applying joining force recommended by manufacturer, using 60 to 90 psi interfacial pressure to form double bead rolled over surface of pipe on both ends.

8) Hold joining force against ends until joint is cool to the touch. Cooling period shall be 30 to 90 seconds per inch of pipe diameter. Heavier wall thicknesses may require longer cooling times as recommended by pipe manufacturer.

9) Upon completing joint, inspect to verify double bead has been formed on both sides, uniformly rounded and consistent in size all around joint. Remove faulty joints and re-joint.

7. HDPE Double Containment Pipe (Containment and Carrier Pipe):
 - a. Install joints of double containment piping system in accordance with pipe manufacturer's instructions. Joints shall be butt fusion welded.

G. Backfilling:

1. Conform to applicable requirements of Section 31 23 05, Excavation and Fill.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

H. Connections to Valves:

1. Install valves as shown and indicated in the Contract Documents.
2. Provide suitable adapters when valves and piping have different joint types.
3. Provide thrust restraint at all valves located at pipeline terminations.

I. Transitions from One Type of Pipe to Another:

1. Provide necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

J. Closures:

1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.

3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
 4. Tape shall be spread flat with message side up before backfilling.
- B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
 2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
 3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
 4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

- A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.
- B. Thrust restraint may be accomplished by using restrained pipe joints, concrete thrust blocks, or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule at the end of this Section.
- C. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.
- D. Restrained Pipe Joints:
1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 05 19, Ductile Iron Process Pipe; lugs and tie rods; or other joint restraint systems approved by ENGINEER.
 - b. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Buried Piping Schedule in this Section. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.
 - c. Thermoplastic and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across joint or other suitable joint restraint system, subject to the approval of ENGINEER.
 - d. Prestressed Concrete Cylinder Pipe Joints: Restrain utilizing clamp type restrained joint, snap ring-type restrained joint, or by welding. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle thrust forces at maximum design stress of 12,500 psi. Thrust forces in longitudinal must be transmitted directly to steel joint bands using welded connections sufficient to carry stresses involved. No allowance for the concrete

to handle tensile forces is allowed. Thrust restraint shall be in accordance with ANSI/AWWA Manual M9.

- e. Joints for Concrete Pipe Other than Prestressed Concrete Cylinder Pipe: Restrain joints utilizing clamp type restrained joint or snap ring-type restrained joint.

E. Concrete Thrust Blocks:

- 1. Provide concrete thrust blocks on pressure piping at changes in alignment of 15 degrees or more, at tees, plugs and caps, and where shown or indicated in the Contract Documents. Construct thrust blocks of Class B concrete.
- 2. Install thrust blocks against undisturbed soil. Place concrete so that pipe and fitting joints are accessible for repair.
- 3. Concrete thrust block size shall be as shown on the Drawings or as approved by ENGINEER.

F. Harnessed lengths of buried pipe shall be as shown on the Drawings.

3.4 WORK AFFECTING EXISTING PIPING

A. Location of Existing Underground Facilities:

- 1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
- 2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.

B. Work on Existing Pipelines or Underground Facilities:

- 1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
- 2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
- 3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
- 4. Conform to applicable project requirements.

3.5 FIELD QUALITY CONTROL

A. General:

- 1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
- 2. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
- 3. Conduct all tests in presence of ENGINEER.
- 4. Remove or protect pipeline-mounted devices that could be damaged by testing.
- 5. Provide all apparatus and services required for testing, including:

- a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
 - 6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
 - 7. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into piping being tested. CONTRACTOR shall provide fluid for other types of testing required.
 - 8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
 - 9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of OWNER. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.
- B. Test Schedule:
 - 1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
 - 2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
 - 3. For piping not listed in Buried Piping Schedule in this Section:
 - a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires separate test.
 - b. Use exfiltration testing, low-pressure air testing, or vacuum testing for other piping.
 - c. Disinfect for bacteriological testing piping that conveys potable water.
 - 4. Test Pressure:
 - a. Use test pressures listed in Buried Piping Schedule in this Section.
 - b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by ENGINEER based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.
- C. Hydrostatic Testing:
 - 1. Preparation for Testing:
 - a. For thermoplastic pipe and fiberglass pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
 - b. For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.

- c. For steel pipe, follow procedures described in ANSI/AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
 - d. For other piping follow procedures described in ANSI/AWWA Manual M9, except that minimum wetting period required immediately prior to testing for asbestos cement pipe shall be 24 hours rather than the 48 hours prescribed for concrete pipe. Wetting period is not required for pipe that is not cement mortar-lined.
 - e. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
 - f. Piping for Hydraulic Fluid, Lube Oil, and Diesel Fuel: Hydrostatically test system using the fluid with which system will function permanently. Allowable leakage is zero. For fluid power systems, pipe manufacturer shall supervise installation and testing of system components, including field piping.
2. Test Procedure:
- a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
 - b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
 - c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
 - d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
 - e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
 - f. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
 - g. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.
 - h. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.
3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
- a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
 - b. Rates based on formula or table in ANSI/AWWA Manual M41:
 - 1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:

- a) Bell and spigot and push-on joints.
- b) Mechanical joints.
- c) Bolted sleeve type couplings.
- d) Grooved and shouldered couplings.
- c. Rates based on make-up allowance in ANSI/AWWA Manual M9:
 - 1) Prestressed concrete cylinder pipe and other types of concrete pipe joined with O-ring rubber gasket sealing members.
- d. Rates based on formula or table in ANSI/AWWA C605:
 - 1) Plastic pipe joined with O-ring gasket sealing members.
- e. Rates based on formula or table in ANSI/AWWA C603:
 - 1) Asbestos-cement pipe.

D. Exfiltration Testing:

- 1. Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment. Groundwater level shall be below the pipe during exfiltration test.
- 2. Before measuring leakage, allow fluid to wet pipe interior for the following period:
 - a. Concrete Pipe: 48 hours.
 - b. Cement Mortar-lined Pipe: 24 hours.
 - c. Asbestos-cement Pipe: 24 hours.
 - d. Other Pipe: Wetting period not required.
- 3. Maintain hydrostatic head during test to equal an elevation two feet above present and future maximum groundwater elevation at pipe segment tested. ENGINEER will determine test water surface elevation for each pipe segment.
- 4. Provide minimum hydrostatic head during test of two feet above crown of upstream end of pipe segment tested.
- 5. Add fluid from test container or from metered supply as required to maintain test water level within three inches of test head throughout the test.
- 6. Test duration shall be at least two hours.
- 7. Allowable Leakage Rates:
 - a. Leakage is defined as the quantity of fluid that must be supplied to pipe segment tested to maintain hydrostatic head within three inches of test head during the test after pipe has been filled and exposed to required wetting period, plus quantity required to refill to original head at end of test.
 - b. Leakage shall not exceed that allowed by authority having jurisdiction.

E. Sewer Testing with Low Pressure Air:

- 1. Plug and bulkhead ends and lateral connections of pipe segment to be tested.
- 2. Required test pressure shall be increased by an amount equal to the elevation of groundwater above invert of lowest point of pipe segment being tested.
- 3. Test in accordance with requirements of authority having jurisdiction.
- 4. If there are no Laws and Regulations covering the test, use test procedures described in the following standards:
 - a. Thermoplastic and HDPE Pipe: ASTM F1417.
 - b. Concrete Pipe: ASTM C924.

c. Clay Pipe: ASTM C828.

F. Vacuum Testing:

1. Plug and bulkhead ends and lateral connections of pipe segment or manhole to be tested.
2. Following set-up of test apparatus, draw vacuum of ten inches of mercury on pipe segment or manhole being tested.
3. Start test upon reaching specified test vacuum. Test duration shall be 15 minutes.
4. Record vacuum drop at end of test. If vacuum drop is greater than one inch of mercury, pipe segment or manhole fails the test and shall be repaired and retested. If vacuum drop is less than one inch of mercury, pipe segment or manhole passes the test.

G. Vertical Deflection Test for Thermoplastic, FRP, and HDPE Pipe:

1. Conduct vertical deflection test at least thirty days after backfill has been placed.
2. Manually pull pin-type vertical gauge mounted on sled through pipe. Gauge shall be manufactured by Quality Test Products, or equal. Set gauge so that sled will stop if vertical deflection of pipe exceeds five percent. Excavate and re-install piping that fails deflection test, and retest.
3. Use rigid ball or mandrel for deflection test, which shall have diameter of at least 95 percent of base inside diameter or average inside diameter of piping, depending on which is specified in applicable ASTM standard, including appendix, to which pipe is manufactured. Perform test without mechanical pulling devices. Re-install and retest pipe segments that exceed deflection of five percent.

H. Examination of Welds:

1. Personnel performing examination of welds shall be qualified to at least Level II in accordance with ASNT SNT-TC-1A.
2. Conform to ASME Boiler and Pressure Vessel Code Section V and applicable articles for examination of welds.
3. Visually examine all welds, Category D Fluid Service, in conformance with ASME B31.3.
4. Examine at least ten percent of welds using liquid penetrant examination.
5. If defect is detected, all welds shall be examined by liquid penetrant examination.
6. At conclusion of liquid penetrant examination, remove penetrant test materials by flushing, washing, or wiping clean with applicable solvents.

3.6 CLEANING AND DISINFECTION

A. Cleaning, General: Clean pipe systems as follows:

1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by ENGINEER, prior to placing in service.

+ + END OF SECTION + +

TABLE 33 05 05-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
SFM	16	PVC	--	--	DR 18			
SFM	18	HDPE	--	--	DR 11			
SFM	8	DI	CE	AC	Class 53	FL		Wet well
SFM	8	HDPE	--	--				Wet well
SFM	12	PVC			DR 14			

The following abbreviations are used in the Buried Piping Schedule.

A. Service Abbreviations

Service	Abbrev		Service	Abbrev.
Sanitary Sewer	SAN		Wastewater	WW
Storm Sewer	ST		Overflow	OF
Combined Sewer	CS		Centrate	CEN
Sanitary Force Main	SFM		Filtrate	FILT
Raw Water	RW		Scum	SCUM
Potable Water	PW		Primary Sludge	PS
City Water	CW		Return Activated Sludge	RAS
Non-Potable Water	NPW		Waste Activate Sludge	WAS
Plant Effluent Water	PEW		Thickened Sludge	TS
Spray Water	SPW		Mixed Sludge	MS
Backwash Water	BW		Digested Sludge	DS
Hot Water Supply	HWS		Chlorine Solution	CLS
Hot Water Return	HWR		Sodium Hydroxide	NAOH
Influent	INF		Sodium Hypochlorite	NAOCL
Effluent	EFF		Polymer Solution	POLYS
Drain	DR		Alum	AL
Process Air	PA		Hydraulic Fluid	HF
Instrument Air	IA		Fuel Oil	FO
Digester Gas	DIG		Lube Oil	LO
Chlorine Gas	CLG			

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Ductile Iron	DI		Polyvinyl Chloride	PVC
Cast Iron	CI		Chlorinated Polyvinyl Chloride	CPVC
Carbon Steel	CS		Polyethylene	PE
Stainless Steel	SS		High Density Polyethylene	HDPE
Copper	C		Fiberglass Reinforced Plastic	FRP
Corrugated Metal Pipe	CMP		Acrylonitrile Butadiene Styrene	ABS
Reinforced Concrete Pipe	RCP		Vitrified Clay	VC
Prestressed Concrete Cylinder Pipe	PCCP			
Non-Prestressed Concrete Cylinder Pipe	CCP			
Steel Cylinder Pipe	SCP			

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Asphaltic Coated	AC
Glass Lined	GL		Polyethylene Wrapped	PEW
Ceramic Epoxy	CE		Painted	P
Fusion Bonded Epoxy Lined	FBEL		Fusion Bonded Epoxy Coated	FBEC
Plastic Lined	PL		Insulated	I
			Galvanized	Galv

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Bell and Spigot	BS		Butt Weld	BW
Restrained Bell and Spigot	RBS		Lap Weld	LW
Push-on Joint	POJ		Butt Fusion Weld	BFW
Restrained Push-on Joint	RPOJ		Solvent Weld	SW
Mechanical Joint	MJ		Sleeve-type Flexible Coupling	SLFC
Restrained Mech. Joint	RMJ		Split Flexible Coupling	SPFC
Soldered	Sd		Plasticized PVC Coupling	PPVC
Brazed	Bz		Grooved or Shouldered End Coupling	GSEC
Threaded	Thd		Flanged	Flg
Compression Sleeve Coupling	CSC		Compression Flange Adapter	CFA

E. Test Abbreviations

Test	Abbrev		Test	Abbrev.
Hydrostatic Test (test pressure in psig)	HYD ()		Process Air Pipe Test (test pressure in psig)	PA ()
Exfiltration	EX		Chlorine Pipe Test	CL
Low-pressure Air Sewer Test	AIR		Disinfection and Bacteriological Testing	DBT
Vacuum Test	VAC		Examination of Welds	EW
Vertical Deflection	VD		No Test Required	NR
Televised Inspection	TV			

SECTION 33 05 07.13

HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
1. The CONTRACTOR (or Subcontractor) shall provide services specializing in Horizontal Directional Drill (HDD) construction to furnish all labor, materials, equipment, and incidentals required to install a 18-in wastewater HDPE force main in two project locations (see drawings for location detail).
 - a. Starting at approximately STA 14+95 adjacent to LA Fitness, proceeding east under 1-75, to STA 27+15
 - b. Starting at approximately STA 38+56, proceeding east underneath Philippi Creek Branch AA, to STA 40+25 on the eastern end of Bikini Road
 2. The HDD work includes, but is not limited to, equipment mobilization, staging, and setup; existing utility locations and pre-drill site investigations; pipe laydown, fusion, installation, and locates; excavation, dewatering, removal of all materials encountered in the drilling operations (including drilling fluid), proper disposal of all material, cleaning, hydrostatic testing, maintenance of traffic, and all incidental tasks, as shown on the Drawings and as specified herein.
 3. This 18-inch wastewater force main HDD application will require the connection of C900 DR18 piping that is being constructed via open cut. For the purposes of this specification, pipe material will be described as HDPE for HDD.
- B. Minimum HDD CONTRACTOR (or Subcontractor) license requirements:
1. Active construction license in Florida to perform HDD construction.
- C. Coordination:
1. Review installation procedures under this and other relevant specification sections.
 2. Coordinate/interface construction of HDD piping with interconnecting buried piping work.
- D. Definitions and Abbreviations:
1. Horizontal Directional Drilling (HDD): A trenchless excavation method that is accomplished in two phases. The first phase consists of drilling a pilot hole along a designed directional path. The second phase consists of enlarging the pilot hole to a diameter suitable for installation of the pipe or conduit, and pulling the pipe or conduit into the enlarged hole. HDD is accomplished using a specialized horizontal drilling rig with ancillary tools and equipment.
 2. HDPE Pipe: High Density Polyethylene Pipe
 3. MPS: Master Pump Station

4. Frac-out: Hydraulic fracturing of the geologic formation surrounding the pipe bore hole.

E. General:

1. The CONTRACTOR shall be responsible for the final constructed product and for furnishing all permits, qualified labor, and supervision necessary for this method of construction.
2. The CONTRACTOR shall furnish all items necessary to perform the horizontal directional drilling operation and construct the pipe to the lines and grades shown on the Contract Drawings.
3. The Work includes, but is not limited to, the following:
 - a. Providing submittals including illustrations and engineering calculations for the work signed and sealed by a Florida-registered Professional Engineer with no less than five years HDD design and construction experience;
 - b. All pre-HDD installation work (i.e., pre-drill reconnaissance and investigations, mobilization, setup)
 - c. Installing, by HDD construction, the 18-in wastewater force main per the specifications and drawings.. The material type and pipe size are as shown on the Drawings and described in these specifications;
 - d. HDD pipe tracing
 - e. Installing supports and restraints;
 - f. Cleaning/Flushing;
 - g. Hydrostatic Testing;
 - h. Installing all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work required to complete the horizontally drilled piping installation; and
 - i. Restoring surface area pavement, curbing and features at boring pits to pre-construction condition.
 - j. Locating system that tracks the horizontal and vertical (x, y, z) location of the pipe.
 - k. As-built drawings to the level of detail shown on the drawings.
 - l. Erosion and sedimentation control to protect drilling mud, disturbed soil, and other construction related items from leaving the defined construction area into waterways, environmental sensitive areas, roadways, and private property.
 - m. Installation of permanent warning signs on the banks of canals, streams, and rivers clearly identifying the nature and location (including depths below design or nature bottom) of subaqueous crossing of lakes, bays, and other larger bodies of water, and in any area where anchoring is normally expected. CONTRACTOR shall obtain ENGINEER's approval for the construction materials and locations of permanent warning signs, prior to their installation. Signs shall have characteristics compatible with surrounding land use, while serving the intended purpose.

F. Related Sections:

1. Section 33 05 05, Buried Piping Installation.
2. Section 40 05 31, Thermoplastic Process Pipe.
3. Section 40 05 33, High Density Polyethylene Process Pipe
4. Section 01 22 13, Measurement of Payment
5. Section 01 29 73, Schedule of Values
6. Section 01 33 00, Submittals Procedures

1.2 REFERENCES

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM D 2774, Practice for Underground Installation of Thermoplastic Pressure Piping, latest edition.
 2. ASTM F1962-99, Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings, latest edition.
 3. Latest edition of ASTM D3350, ASTM F-714.
 4. State of Florida, Department of Transportation (FDOT) Standards, Utility Accommodation Manual, latest edition
 5. Sarasota County Utility Code
 6. Sarasota County Utility Standard Details and Specifications

1.3 QUALITY ASSURANCE, QUALIFICATIONS, and REFERENCES (NOT USED)

1.4 SUBMITTALS

The CONTRACTOR shall not commence work on any HDD related items until the submittals are reviewed and accepted by the ENGINEER and Sarasota County (OWNER).

A. Action Submittals:

1. Submit for review and acceptance, three weeks prior to the start of construction, the following:
 - a. Horizontal Directional Drilling Plan: describing the equipment, methods, procedures (pilot hole drilling, insertion, reaming, pullback, coating protection, internal cleaning, internal gauging, hydrostatic tests, dewatering, purging, erosion and sedimental control plan, etc.), monitoring procedures (pressures, depth, alignment, placement, entrance and exit points, etc.), construction sequence and scheduling, contingency plans, and other items of concern to be performed during the horizontal directional drilling process. The plan shall indicate the diameter of the pilot hole, rig pulling capacity, torque, and mud pumping capabilities. Include a description of methods and precautions the CONTRACTOR proposes to use to prevent exceeding the pipe manufacturer's approved safe yield tensile strength during pull back, precautions to prevent inadvertent return or discharges of drilling mud along the project site, roadway or adjacent waterways, and contingency plans for immediate cleanup of inadvertent returns or discharges, should they occur. The Plan shall also include anticipated sizes and locations of pits and sediment and erosion control methods to be employed.
 - b. A Project Safety Plan.
 - c. Arrangement drawings and technical specifications of the machine and equipment (including any modifications), three-year experience record

with this type of machine and a copy of the manufacturer's operation manual for the machine.

- d. The CONTRACTOR shall submit the following items:
1. Complete details/calculations of the significant factors and constraints associated with HDD operations including, but not limited to, the necessary restraints required for PVC pipe expansion and contraction, all drilling fluid mixtures and pressures, bit pressures, minimum and maximum bore hole pressures, hydrostatic tests and cleaning, and testing procedures.
 2. Method of monitoring and controlling the specified line and grade of HDD excavation and HDPE installation including, but not limited to, the methods, procedures, reliability, and necessary equipment to be used during the HDD operations.
 3. Complete details of the muck/spoils containment, dewatering, drying, and removal methods, procedures, equipment, contingency plan and off-site disposal location.
 4. Complete details of the methods, procedures, and equipment arrangement to be used during the HDPE pipe storage, assembly, fusion, installation, cleaning, and testing.
 5. Plan for pre-drill site investigations including but not limited existing underground utility identification and location, easement limits, property and right-of-way limits.
 6. Proposed contingency plans for the protection of the adjacent and overlying site features, waterways, utility lines, and other underground structures. Contingency plans shall include, but not be limited to, the complete details of the methods/procedures, equipment to be used, etc. for critical phases and areas of the HDD operations.
 7. Provide plan and profile of proposed HDD, indicating depth, angle of deflection, and radius of all pipe bends along the bore.
 8. Pipe Material Calculations: The HDD Subcontractor's PE shall provide calculations determining the maximum pulling force that may be anticipated during the pullback operation to overcome theoretical frictional forces. The calculations shall be accompanied by written certification by the PE verifying that the maximum calculated pulling force will not exceed the manufacturer's recommended yield tensile strength and factor of safety for the proposed pipe material. The maximum allowable tensile load imposed on the pull section shall be equal to 90 percent of the product of the specified minimum yield strength of the pipe and the area of the pipe section. If more than one value is involved for a given pull section, the lesser shall govern.
 9. Bending Radius: The CONTRACTOR/HDD Subcontractor shall submit calculations establishing the maximum bending radius of the drill pipe. The calculations shall be accompanied by written certification by the PE verifying that the maximum bending radius shall not be exceeded along the force main alignment.
 10. Bore path monitoring and installation verification plan: summarizing procedures, equipment, instrumentation, responsible personnel (with experience information), and

reporting provisions.

11. Details of proposed means and methods that will be used to demonstrate that the HDD has been performed in accordance with the drawings, specifications, and approved submittals.
- B. Quality Control Methods: At least 15 days prior to the start of HDD, the CONTRACTOR shall submit a description of his quality control methods for the HDD operations, to the ENGINEER. The submittal shall describe:
1. Procedures for controlling and checking line and grade.
 2. Field forms for establishing and checking line and grade.
- C. Closeout Submittals:
1. Record drawings of the HDD installations prepared by licensed surveyor and HDD subcontractor's PE. Submit prior to the Substantial Completion.
 2. As-built drawings of pipe butt fusion joint coordinates.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Specification No. 33 05 05, Buried Piping Installation, regarding delivery, storage, and handling.

1.6 JOB CONDITIONS

- A. The CONTRACTOR shall inspect the area(s) within the vicinity of the project and the immediate area of the Work and become thoroughly familiar with the natural and man-made features encompassed about the Project.
- B. Existing Utilities:
1. The CONTRACTOR shall be responsible for locating any and all underground facilities within the project area, regardless of the OWNER's or ENGINEER's previous efforts in this regard. The CONTRACTOR shall notify "Sunshine State One Call of Florida" and make arrangements to positively locate and stake or mark out all existing utility lines, cables, or other underground facilities. Any facilities which are located within 10 feet of the designed drill alignment shall be exposed for inspection.
 2. Should uncharted or incorrectly charted piping or utilities be encountered during the Work, the CONTRACTOR shall inform the ENGINEER and OWNER and get instructions on how to proceed.
 3. If damage occurs to any utility in the project area as a result of the HDD construction work, the CONTRACTOR shall be responsible for all losses and repair costs damage. Damaged utilities shall be repaired to the satisfaction of the utility owner. The HDD Contractor shall cooperate with the OWNER and utility companies in keeping respective services and facilities in operation.
 4. Modify drilling practices and downhole assemblies to prevent damage to existing facilities.
 5. Do not interrupt existing utilities serving facilities occupied and used by the OWNER or others, except when permitted in writing by the OWNER and then only after acceptable temporary utility services have been provided.

6. Coordinate with utility companies for shut-off of services, if required.

Dust Control: The CONTRACTOR shall conduct all operations and maintain the area of the Work activities, including sweeping and sprinkling Work areas, so as to minimize creation and dispersion of dust.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Piping:
Refer to Section 40 05 33 for the HDPE pipe material specifications.
- B. Tracer Wire
The CONTRACTOR shall provide a continuous (without splices), insulated TW, THW, THWN, or HMWPE insulated copper, 10-gauge or thicker wire for pipeline locating purposes by means of an electronic line tracer.
 1. The wires must be installed along the entire length of the HDD constructed pipelines.
 2. Where terminated above-ground, at least two tracer wires must be attached to the HDD pipe during the pullback and a minimum of 4 feet shall be coiled at the point of termination. A green locator (model No 1253 as manufactured by Automation Products Co.) shall be installed at grade.
 3. The CONTRACTOR shall coordinate location and interface of the termination points of the tracer wire provided by the HDD Subcontractor with the tracer wire leads of the remainder of the pipeline route.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. The CONTRACTOR shall be responsible for his means and methods of HDD construction and shall ensure the safety of the work, the CONTRACTOR's employees, the public, and adjacent property, whether public or private.
 2. The CONTRACTOR shall anticipate that portions of the drilled excavation will be below the groundwater table.
 3. The CONTRACTOR shall comply with all local, state, and federal laws, rules, and regulations at all times to prevent pollution of the air, ground, and water.
 4. If there is a conflict between the CONTRACTOR's construction documents (including the piping manufacturer's recommendations) and the Drawings or Specifications, the CONTRACTOR shall notify the ENGINEER and OWNER in writing and receive direction before proceeding.
- B. Drilling Operations:

1. Directional drilling/boring shall use techniques of creating or directing a borehole along a predetermined path to a specified target location. This shall involve the use of mechanical and hydraulic deviation equipment to change the boring course and include instrumentation to monitor the location and orientation of the boring head assembly along a predetermined course.
2. Drilling shall be accomplished with fluid assisted mechanical cutting. The CONTRACTOR shall transport spoils from the job site for proper, safe, and legal disposal. Under no circumstances will the drilling spoils be permitted to be dumped into waterways, sanitary, storm, or any other public or private drainage system.
3. Steering shall be accomplished by the installation of an offset section of drill stem that causes the cutterhead to turn eccentrically about its centerline when it is rotating. When steering adjustments are required, the cutterhead offset section is rotated toward the desired direction of travel and the drill stem is advanced forward without rotation.

C. Tolerances:

1. The CONTRACTOR shall at all times provide and maintain instrumentation that will accurately locate the pilot bore/hole and measure drilling fluid flow and pressure.
2. The CONTRACTOR shall provide the ENGINEER and OWNER access to all data and readout pertaining to the position of the bore head and fluid pressures and flows. No information pertaining to the position or inclination of the pilot bores shall be withheld from the ENGINEER.
3. The CONTRACTOR is responsible for horizontal and vertical alignment of the pilot drill and final installed piping. The pilot drill shall conform to the conduit alignment as shown on the approved Shop Drawings. The horizontal alignment shall always remain within Sarasota County or FDOT right of way, or dedicated County utility easement.
4. The CONTRACTOR shall submit all proposed changes to the vertical alignment shown on the Drawings to the ENGINEER for approval prior to commencing work.
5. Deviations between the recorded and design bore path shall be calculated and reported on the daily log. If the deviations exceed tolerances specified elsewhere, such occurrences shall be reported immediately to the ENGINEER. The CONTRACTOR shall undertake all necessary measures to correct deviations and return to design line and grade.
6. The CONTRACTOR shall provide the actual horizontal and vertical alignment of the pilot bore at intervals not exceeding 20 feet. This "as-built" plan and profile shall be updated as the pilot bore is advanced. The CONTRACTOR shall have the entry and exit pits surveyed in advance by a licensed professional surveyor for the purpose of establishing benchmark, grades, and piping locations for the record drawings.
7. Each exit point shall be located as shown on the Drawings with an over-length tolerance of 5 feet for directional drills of 500 linear feet or less and 10 feet for direction drills greater than 500 linear feet. Alignment tolerance of 5 feet left/right with due consideration of the position of the other exit points and the right of way.

8. Should the CONTRACTOR exceed the limits described above, a new pilot drill shall be performed at the expense of the CONTRACTOR and at no cost to the OWNER.
 9. If requested by the OWNER or the ENGINEER, the CONTRACTOR shall provide full explanation or details regarding any technical means, methods, or equipment necessary to accomplish the work described herein.
 10. The maximum pipeline bending radius shall conform to the manufacturer's recommendations.
- D. Ream and Pullback:
1. After an initial bore has been completed, a reamer will be installed at the termination/exit pit and the pipe will be pulled back to the starting/entry pit.
 2. Reaming operations shall be conducted to enlarge the pilot after acceptance of the pilot bore. The number and size of such reaming operations shall be conducted at the discretion of the CONTRACTOR.
 3. The maximum allowable pull exerted on the HDPE pipelines shall be measured continuously and limited to the maximum value allowed by the CONTRACTOR's calculations so that the pipe or joints are not overstressed (refer to Section 1.4 c of this specification).
 4. A swivel shall be used to connect the pipeline to the drill pipe to prevent torsional stresses from occurring in the pipe. Pipe pull heads shall be specifically designed for use with HDPE, and shall be as recommended by the pipe manufacturer.
 5. The lead end of the pipe shall be closed during the pullback operation.
 6. The pipelines shall be adequately supported by rollers and side booms and monitored during installations so as to prevent over stressing or buckling during the pullback operation.
 7. Support/Rollers shall be spaced at a maximum of 60 feet on centers, and the rollers to be comprised of a non-abrasive material arranged in a manner to provide support to the bottom and bottom quarter points of the pipeline allowing for free movement of the pipeline during pullback.
 8. The pipe shall be pulled beyond the exit pit by a minimum distance of one percent of the total pipe length and allowed to reach equilibrium before any other work is performed on the pipe (per the shop drawings). A minimum period of 12 hours (or longer if recommended by the pipe manufacturer), shall be allowed for the pipe material to reach equilibrium before any further work is performed.
 9. Should the pipe become lodged during the pullback operation, the HDD Subcontractor shall be responsible for all additional costs to dislodge the pipe.
- E. Joining Pipe Sections (Pipe Joints):
1. Polyethylene pipe and fittings shall be joined by the thermo butt-fusion process. Refer to Specification 33 05 05, Buried Piping Installation.
 2. Mechanical Transition (from one PVC Pipe to HDPE Pipe): Provide all necessary adapters, specials and connection pieces required at piping interface connections. Connection of the HDD Polyethylene Pipe to the PVC, C900 pipe shall be through a mechanical restraint joint harness assembly which shall consist of A polyethylene "stub-end" Special with raised collar thermally butt-fused to the ends of the PVC pipe. Refer

to the Drawings for details. The stub-end configuration shall fit into the standard bell end of a C900 PVC pipe and utilize a restraint harness (Megalug restraint or as specified in the drawings and PVC pipe technical specifications).

F. Handling Drilling Fluids and Cuttings:

1. All operations involving drilling mud shall be controlled and monitored by the CONTRACTOR to ensure containment. The CONTRACTOR shall make adequate provisions for handling the drilling fluids, or cuttings at the entry and exit pits. Drilling fluids and/or cuttings shall not be allowed to discharge into the waterway or site drainage features.
2. Pits constructed at entry and exit point areas shall be constructed to completely contain the drill fluid and prevent escape to the waterway or site drainage features.
3. The CONTRACTOR shall utilize drilling tools and procedures, which will minimize the discharge of any drill fluids. The HDD Contractor shall comply with all mitigation measures listed in the required permits and elsewhere in these specifications.
4. The CONTRACTOR shall employ the best efforts to maintain full annular circulation of drilling fluids. Drilling fluid returns at locations other than the entry and exit points (inadvertent returns) are not allowed and shall be minimized. In the event that annular circulation is lost, the CONTRACTOR shall take immediate steps to restore circulation. If inadvertent surface returns or drilling fluids occur due to "frac-out" they shall be immediately contained with hand placed barriers (i.e., hay bales, sandbags, silt fences, collection pumps, etc.) in accordance with the approved erosion and sedimental control plan and collected using pumps as much as practical. If surface returns are too great to control, drilling operations shall be suspended until surface return volumes can be brought under control.
5. Equipment (graders, front-end loaders, etc.) and materials (such as ground sheets, hay bales, silt fencing, and absorbent pads) for cleanup and contingencies shall be provided by the CONTRACTOR and be readily available and maintained within the work areas. The HDD Subcontractor shall also have readily available material and equipment to contain and remove "frac-out" discharge occurring into the canal, such as turbidity barriers.
6. The CONTRACTOR shall establish bermed or sandbagged pits lined with sealed plastic of sufficient size to accommodate the volume of drilling mud anticipated plus a 2-foot freeboard. The bermed areas shall be maintained by the CONTRACTOR to ensure containment and prevent loss of drilling mud to the adjacent environment.
7. Upon completion of the HDD installation, the CONTRACTOR shall remove and properly, safely, and legally dispose all spoils from the pits and site. All pits shall be restored to their original conditions including but not limited to repair/ replacement of all affected pavement, curbing, landscaping, and stormwater drainage features and/or structures.

3.2 WORK AFFECTING EXISTING PIPING

A. Location of and Separation from Existing Piping:

1. Locations of existing piping shown shall be considered approximate.
2. The CONTRACTOR/ shall determine the true location of existing

pipelines and other underground utilities, or facilities which could be disturbed during earthwork operations, or which may be affected by CONTRACTOR's Work in anyway.

3. The CONTRACTOR shall maintain the required separation distance between the new pipelines as well as between the new and existing pipelines and/or other utilities. Refer to Specification 33-05-05, Buried Piping Installation, for separation requirements.

3.3 CLEANING AND HYDROSTATIC PRESSURE TESTING OF PIPING

- A. The CONTRACTOR shall clean the HDD portion of the pipeline in accordance with Specification 33 05 05, Buried Piping Installation. Cleaning and flushing of the pipes shall remove all foreign material and fluids that may have contaminated the pipe interior during the pipe installation. If a cleaning agent is used, the cleaning agent product shall be approved by the ENGINEER prior to its use in the pipelines.
- B. Following cleaning and flushing, the CONTRACTOR shall hydrostatic pressure test all HDD piping in accordance with Specification 33 05 05, Buried Piping Installation, prior to completing tie-in connections with associated piping.
- C. The CONTRACTOR shall complete pipeline disinfection in accordance with Specification 33 05 05, Buried Piping Installation, in conjunction with the remainder of the installed pipelines.

3.4 TRACER WIRE TESTING

- A. Upon completion of the HDD, CONTRACTOR shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe.
- B. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of the OWNER or ENGINEER.
- C. If the wire is broken, the CONTRACTOR shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

+END OF SECTION +

SECTION 33 05 07.23

UTILITY BORING AND JACKING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment, dewatering, supervision and incidentals required to furnish and install casing and carrier pipe as shown on the Drawings and specified herein.
- B. Related Sections
 - 1. Section 33 05 05, Buried Piping Installation
 - 2. Section 40 05 31, Thermoplastic Process Pipe
 - 3. Section 01 51 05, Temporary Utilities

1.2 QUALITY ASSURANCE

- A. Installer's Qualifications and Experience:
 - 1. Installer shall be a specialist in the construction of casing pipes by jacking and boring and shall have at least five (5) years experience in this specialty. Within the past five (5) years, installer shall have personally constructed completely not less than five (5) similar installations, which are comparable in diameter and length to that shown and specified herein.
 - 2. Use only personnel thoroughly trained and experienced in the skills required. The field supervisor of boring operations and the boring machine operator shall have not less than 12 months experience in the operations of the equipment being used.
 - 3. Welds shall be made only by welders, workers and welding operators who have been previously qualified by tests as prescribed by the Structural Welding Society to perform the type of work required. Show proof of certification when requested by the OWNER. Certification shall not be more than 6 months old from the date the work is to be performed.
- B. Requirements of Regulatory Agencies:
 - 1. The OWNER has obtained permission from the applicable authorities for locating the pipeline under the facilities. The CONTRACTOR shall comply with all provisions of these permits at their own expense. All crossings shall be as specified in the Florida Department of Transportation's "Utility Accommodation Manual."
 - 2. The CONTRACTOR shall, in addition to paragraph 1 above, obtain all additional permits, provide insurance, bonds, and guarantees, and all else required by the governing authorities at no additional cost to the OWNER. The CONTRACTOR's responsibility under this paragraph may include, but is not limited to the following:
 - a. Survey and existing utility locates.
 - b. Constructing and removing temporary facilities or structures.
 - c. Providing details of construction methods
 - d. Providing detailed construction schedules.
 - e. Reimbursing the applicable authority for all expenses incurred by them

- in connection with the work.
 - f. Traffic maintenance.
 - g. Necessary clean-up and restoration.
 - h. As-built survey documentation.
- C. Tolerances:
 - 1. The casing pipes shall be installed on the lines and grades shown in the Drawings and within tolerances required to allow the pipeline to be installed in accordance with the lines and grades shown in the Drawings.
 - 2. The maximum allowable tolerances are as follows:
 - a. Allowable horizontal tolerance (ft): 0.50
 - b. Allowable vertical tolerance (ft): 0.1
- D. Reference Standards – Comply with the relevant section of the latest revisions of the following standards:
 - 1. ASTM A139 Grade B, Electric-Fusion (ARC Welded) Steel Pipe.
 - 2. ASTM A153, Zinc-Coating (Hot Dip) on Iron and Steel Hardware.
 - 3. ASTM A 276 Standard for stainless and heat-resisting steel bars and shapes
 - 4. ASTM A307, Low-Carbon Steel Externally and Internally Threaded Standard Fasteners.
 - 5. ASTM A569, Hot-Rolled Carbon Steel Sheets and Strip, Commercial Quality.
 - 6. ASTM C 33 Standard specification for concrete aggregates
 - 7. ASTM C 579 Standard test method for compressive strength of chemical resistant mortars, grouts, monolithic surfacing and polymer concretes
 - 8. ASTM D 4161 Standard specification for "fiberglass" pipe joints using flexible elastomeric seals
 - 9. ASTM D 6783 Standard specification for polymer concrete pipe
 - 10. ASTM F 477 Specification for elastomeric seals (gaskets) for joining plastic pipe
 - 11. AASHTO, Interim Specification for Steel Tunnel Liner Plates.
 - 12. AREA Chpt. 1, Part 4, "Jacking Culvert Pipe through Fills."
 - 13. AREA Chpt. 1, Part 5, "Specification for Pipelines Conveying Non-Flammable Substances."
 - 14. AWS D1.1, Structural Welding Code.
 - 15. ASTM S252, Welded and Seamless Steel Pipe Piles.
 - 16. DIN 54815-1&2
 - 17. OSHA.
 - 18. State of Florida, Department of Transportation (FDOT) Standards, Utility Accommodation Manual, latest edition.

1.3 SUBMITTAL

- A. Installation Methods: Submit surveyed drawings and descriptions showing methods and equipment for the installation of the casing pipes, including sizes and locations of the jacking and receiving pits; sequence of installation by location, etc. for approval by the ENGINEER. Prepare a report of subsurface information, dewatering methods, jacking pit elevations and profile of proposed bore. The report shall be submitted to the OWNER and ENGINEER.
- B. Technical data, test reports, work schedules and other information required by the authority having jurisdiction.

- C. Certificates: Certificate of Conformance in accordance with paragraph 21.1 of ASTM A139.
- D. The CONTRACTOR must submit for approval the following documentation for review by the ENGINEER and any other regulatory agency for each crossing:
 - 1. Noise Reduction Program
 - 2. Solids Control and Drilling Procedures
 - 3. Carrier Pipe Installation, Hydrostatic Testing, and Pigging Procedures
 - 4. Contingency Plans including the CONTRACTOR's proposed responses to the following occurrences:
 - a. Loss of returns/loss of circulation of drilling fluid
 - b. Hydrofracture
 - c. Obstructions encountered during drilling
 - d. Broken drill/auger bit
 - e. Pipe product collapse

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery:
 - 1. Exercise special care during delivery so as not to damage the casing pipe and carrier pipe.
 - 2. Damaged materials shall be rejected by the OWNER and/or ENGINEER and replaced by the CONTRACTOR at no additional cost to the OWNER.
 - 3. Deliver materials to such locations so as to avoid excessive handling.
- B. Storage:
 - 1. Store casing pipe and carrier pipe on blocking for protection from corrosion until incorporation into the Work in accordance with manufacturer's recommendation.
 - 2. Store in areas approved by the OWNER and ENGINEER.
 - 3. The ENGINEER and OWNER shall be permitted access to inspect the materials in storage areas
- C. Handling:
 - 1. Handle materials in a manner so as to avoid damage.
 - 2. Materials damaged during handling shall be repaired or replaced as ordered by the ENGINEER.

1.5 JOB CONDITIONS

- A. Site information: Refer to Division 0.
- B. Protection: Provide guardrails, fences, signs, lights, barricades, barrels, and all other protective items necessary in accordance with the requirements of all applicable permits, laws, regulations, and ordinances, and as necessary to prevent damage or injury to private or public property or to workmen or the general public.
- C. Adequately support and protect utilities and facilities that are encountered in, or may be affected by the work.
- D. The CONTRACTOR shall observe all necessary and appropriated safety precautions when working on roadway right-of-way or property. To this end,

the CONTRACTOR shall provide a qualified watchmen to warn workmen of the approach of any vehicles or other moving equipment upon the highway, and to keep all workmen or other persons, equipment and materials from the highway including any power, communication, and signal wires, so that there will be no contacts with vehicles. CONTRACTOR shall comply with all regulatory requirements.

- E. Maintain necessary air exchanges in the pipe, when hand excavating, in a condition suitable for the health of the workmen at all times.
- F. Existing Structures: The Drawings show certain existing facilities and surface and underground structures located on or adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of the CONTRACTOR. The CONTRACTOR shall explore ahead of the required Work to determine the exact location of all structures. They shall be supported and protected from damage by the CONTRACTOR. If they are broken or damaged, they shall be restored immediately by the CONTRACTOR at no additional cost to the OWNER.
- G. Existing Utilities: Locate existing underground utilities in the areas of Work. If utilities are to remain in place, provide adequate means of protection during all operations.
 - 1. Cooperate with the OWNER and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 2. Do not interrupt existing active utilities except when permitted in writing by the OWNER or utility owner and then only after acceptable temporary utility services have been provided.
 - 3. Coordinate with utility companies in writing prior to proceeding with work activities. Any shut downs of services shall be in conformance with Section 01 51 05, Temporary Utilities.

1.6 GUARANTEE

- A. Guarantee of work completed by the CONTRACTOR shall be as specified in the General Conditions, except that longer periods may be required where noted in the permits or specified by authorities have jurisdiction.

1.7 GENERAL PROCEDURES

- A. Install welded steel pipe casings as shown or specified, in accordance with approved jacking and boring methods.
- B. Attend all meetings and provide any necessary data, survey, reports, information, details, and construction schedules as requested by the OWNER.
- C. The scheduling of all construction activities under the highway or railroad right-of-way shall consider traffic patterns in order to minimize the interruption of traffic. The CONTRACTOR shall include the cost for such procedures in the bid prices and shall not be entitled to any change in Contract Amount on account of such procedures.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Casing Pipe:

1. Casing pipe shall be new and unused steel pipe meeting the requirements of ASTM A139, Grade B, leakproof construction capable of withstanding AASHTO HS-20 wheel loading for all crossings at the depths shown. Impact factor shall be 1.5. Pipe shall be seamless or have not more than one longitudinal weld.

Carrier Pipe, Nominal Diameter (in.):	Steel Casing Pipe, Nominal Diameter (in.):	Casing Pipe Minimal Wall Thickness (in.)
4	12	0.188
6	14	0.188
8	18	0.250
12	24	0.469
16	30	0.505

2. If the casing pipe is furnished in sections and the casing pipe requires field welding, then the casing pipe shall be furnished with plain ends, mill beveled for field butt welding. Field welded joints shall be performed by AWS D.1.1 Certified Welders and shall be full penetration single-vee groove, butt type welds around the entire circumference of the pipe. All welding shall receive non-destructive testing. Copies of the test report shall be sent to the ENGINEER.
3. For all work performed within Florida Department of Transportation right-of-way, the casing pipe shall be a minimum of 40-foot lengths.
4. Coatings: The exterior and interior surfaces of the casing pipe shall receive surface preparation conforming to SSPC-SP6. One of the following coating systems shall be applied in the shop:
 - a. Kop-Coat, Carboline Co.
 - 1) Primer: Kop-Coat 340 gold primer – 1 coat, 2 to 4 dry mils.
 - 2) Finish: Bitumastic 300M – 2 coats, 8 to 10 dry mils per coat.
 - b. Tnemec:
 - 1) Primer: 37H Chem-Prime HS - 1 coat, 2.0 to 3.5 dry mils.
 - 2) Finish: Tneme-Tar – 2 coats, 8.0 to 10.0 dry mils per coat.
 - c. Or approved equal.
5. CONTRACTOR may use a mechanical joint type pipe in lieu of welded joints. The pipe joint shall be flush with the inside and outside diameter. The joints shall be manufactured by Permalok or ENGINEER approved equal.
6. Casing pipe shall be in accordance with this Section.

B. Carrier Pipe:

1. Carrier pipe shall be as indicated on the Drawings and in this Section and in accordance with Section 33 05 05, Buried Piping Installation and Section 40 05 31, Thermoplastic Process Pipe.

C. Annular Spacers and End Seals:

1. Carrier pipe within casings installed by microtunneling or bore/jack operations shall be supported within the steel casing by means of annular spacers.
2. Annular spacers shall be a two piece prefabricated unit by a single manufacturer. All casing spacers in a single casing pipe crossing shall be by the same manufacturer. Casing spacers shall have a shell made from either 304 stainless steel, 14 gauge mild steel which has been heat fusion coated with PVC plastic, (PVC coating shall be .01 inch thick over the entire band including the runner studs) or high density polyethylene. Casing spacers on 16 inch and smaller carrier pipe shall have 8 inch wide steel bands and casing spacers on 18 inch and larger carrier pipe shall have 12 inch wide steel bands, except high density polyethylene spacers shall have high density polyethylene bands. All casing spacers for 14 inch and smaller pipe size shall have four 10 gauge or 14 gauge steel risers with runners and casing spacers for 16 inch and larger pipe shall have six 10 gauge or 14 gauge steel risers with runners (two top and four bottom), except high density polyethylene spacers shall have one riser for every diameter inch of carrier pipe. The runners (risers) shall be either glass reinforced plastic, UHMW polymer or high density polyethylene. All nuts, bolts and washers shall be 304 stainless steel. All risers over 2 inches in height shall be reinforced. Wooden skids are not an acceptable.
3. The spacers shall be placed in 6 foot intervals. A spacer shall be placed such that it supports the carrier pipe within 2 feet of the casing ends and a minimum of three spacers per 20-foot pipe section. For pipe sections longer or shorter than 20 feet, follow the manufacturer's instructions and recommendations.
4. The CONTRACTOR shall verify size, position, spacing, and configuration of spacers with manufacturer.
5. The CONTRACTOR shall verify the tolerances of the casing spacer are compatible with the carrier pipes outside diameter including provisions for the pipe to be slightly out-of-round.
6. Manufacturer: Spacers shall be manufactured by the following:
 - a. PSI, C12G-2
 - b. Casey Cascade, CCS-12" Width Minimum
 - c. Or approved equal.
7. Ends of casings shall be sealed around end seal made of 1/8" thickness rubber and stainless steel bands that will completely close both ends of the casings.
8. End seals shall be manufactured by
 - a. Public Works Marketing
 - b. PSI
 - c. Advance Products & Systems, Inc.
 - d. Casey Cascade
 - e. or approved equal

D. Sand Backfill

1. Sand shall be dry (water content no more than 6% or less than 3%), free from organic matter, and containing not over 5% by weight of deleterious substances. It shall be hard, dense, durable, clean, sharp, and graded evenly from fine to coarse as follows:

Sieve Size	Percent By Weight
3/8 inch	100
No. 4	97-100
No. 8	79 – 85
No. 16	60-78
No. 50	10-20
No. 100	0-4

2. Sand shall have a fineness modulus per ASTM C 136 of between 2.70 and 3.30.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of the crossings shall be by jacking or boring and shall conform in all respects to the requirements contained herein and other applicable standards.
- B. Lines and Grades: The CONTRACTOR shall be responsible for establishing and maintaining proper line and grade at each crossing.
 1. The CONTRACTOR shall periodically check his line and grade to assure conformance with the line and grade shown on the Drawings.
 2. Extra work required because of the CONTRACTOR'S failure to maintain the proper line and grade, as shown on the drawings, shall be performed, by the CONTRACTOR, at no additional cost to the OWNER.

3.2 INSPECTION

- A. As required by the ENGINEER, OWNER, FDOT or regulatory agencies.

3.3 PREPARATION

- A. Work pits at each end of the crossings shall be sufficiently large to permit satisfactory installation of the casing pipe or direct jacking pipe. All excavation, backfill, sheeting, shoring, bracing, and dewatering shall comply with the applicable requirements of Section 31 23 05, Excavation and Fill and the requirements of the applicable authorities having jurisdiction.
- B. The CONTRACTOR shall dispose of excess excavated material and drilling mud/cuttings in legal manner.

3.4 INSTALLATION

- A. Installation of Casing Pipe by Jacking:
 1. Install in accordance with current Columbia County, and Florida Department of Transportation specifications, rules and requirements latest editions.
 2. Design bracing and backstops and use jacks of sufficient rating such that jacking can be accomplished in a continuous manner until the leading edge of the pipe reaches the final positions shown on the Drawings.

3. If voids develop around the casing pipe as it is jacked, pump cement grout to fill all such voids.
 4. Fill all voids as specified hereafter as soon as possible after completion of jacking operation.
 5. The installation of pipe and fittings shall be in accordance with the project plans and specifications and the manufacturer's recommended practices.
 6. Textile slings, anchor lifting devices and/or a forklift are recommended.
- B. Installation of Casing Pipe by Boring:
1. The boring method shall consist of pushing the pipe into the fill with a boring auger rotating inside the pipe to remove the soil.
 2. Provide the front of the casing pipe with suitable mechanical arrangements or devices that will positively prevent the auger and cutting head from leading the pipe so that there will be no unsupported excavation ahead of the pipe.
 3. The equipment and mechanical arrangements or devices used to bore and remove the earth shall be removable from within the casing pipe in the event an obstruction is encountered.
 4. The face of the cutting edge shall be arranged to provide reasonable obstruction to the free flow of soft or poor soil.
 5. Do not use water or other liquids to facilitate casing emplacement or spoil removal.
 6. If voids develop around the casing pipe as it is bored, pump cement grout to fill all such voids.
 7. Fill all voids as specified hereafter as soon as possible after computation of boring operation.
 8. The installation of pipe and fittings shall be in accordance with the project plans and specifications and the manufacturer's recommended practices.
 9. Textile slings, anchor lifting devices and/or a forklift are recommended.
- C. Obstruction: If an obstruction is encountered during installation to stop the forward action of the casing pipe, and it becomes evident that it is impossible to advance the pipe, the CONTRACTOR shall remove the obstruction at the leading end of the casing pipe. No blasting shall be permitted.
- D. Installation of the Carrier Pipe:
1. After completion of the casing pipe, the carrier pipe shall be installed and pressure tested by an approved method.
 2. Care shall be taken to prevent undue disturbances of the joints.
 3. The carrier pipe shall be laid on the line and grade shown on the Drawings.
 4. The CONTRACTOR shall repair, replace or take whatever action is deemed necessary by the ENGINEER to correct all disturbed joints at no additional cost to the OWNER.
 5. The carrier pipe shall be restrained its full length.
 6. The CONTRACTOR shall block the carrier pipe in place using casing spacers as shown on the Drawings and specified herein.
- E. Annular Space: The annular space between the carrier pipe and casing pipe shall be filled with sand backfill.
- F. End Seals:
1. After the carrier pipe is installed in the steel casing and successfully pressure tested, construct end seals as shown on the Drawings and as

- specified herein.
2. Prior to the installation of the end seals, the carrier pipe shall be properly and sufficiently secured against flotation and against all movement, which would disturb joints.
 - a. The CONTRACTOR shall be responsible for all joints.
 - b. The CONTRACTOR shall repair, replace, or take whatever action is deemed necessary by the ENGINEER to correct all disturbed joints at no additional expense to the OWNER.

+ + END OF SECTION + +

SECTION 33 05 13

MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all precast, cast-in-place and masonry manholes and structures.
- B. General:
 - 1. Manholes and structures shall conform in shape, size, dimensions, material, and other respects to the details shown or as directed by ENGINEER.
 - 2. Cast-iron frames, grates and covers shall be the standard frame and grate or cover unless otherwise shown and shall be as specified in Division 5, Metals.
 - 3. Concrete for cast-in-place manholes and structures and for inverts in precast and masonry manholes and structures shall be Class "A" and shall conform to the requirements specified under Section 03 00 05, Concrete.
 - 4. All manholes and structures shall be precast construction, unless otherwise shown. All sanitary or process manholes and structures carrying untreated wastewater shall be PVC lines or coated with Saueriesen or Sewer Shield 100.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 05 50 13, Miscellaneous Metal Fabrications.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American Society for Testing and Materials, (ASTM).
 - a. ASTM C 32, Specification for Sewer and Manhole Brick (made from Clay or Shale).
 - b. ASTM C 139, Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
 - c. ASTM C 140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - d. ASTM C 207, Specification for Hydrated Lime for Masonry Purposes.
 - e. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.
 - 2. American Water Works Association, (AWWA).
 - a. AWWA C302, Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:

Home Depot MPS and FM
Manholes and Structures
30036073

- a. Submit drawings showing design and construction details of all precast concrete and cast-in-place manholes and structures, including details of joints between the manhole bases and riser sections and stubs or openings for the connections.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES AND STRUCTURES

- A. Precast manholes and structures shall conform to the details shown. Provide cast-in-place concrete bases where shown.
- B. Except where otherwise specified precast manhole components shall consist of reinforced concrete pipe sections especially designed for manhole construction and manufactured in accordance with ASTM C 478, except as modified herein.
- C. Precast, reinforced concrete manhole bases, riser sections, flat slabs and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing or other imperfections.
- D. Joints between manhole components shall be the tongue and groove type employing a single, continuous rubber O-ring gasket and shall conform to AWWA C302. The circumferential and longitudinal steel reinforcement shall extend into the bell and spigot ends of the joint without breaking the continuity of the steel. Joints between the base sections, riser sections and top slabs of manholes 72-inches in diameter and less shall be rubber and concrete joints. Joints for manhole components greater than 72-inches in diameter shall be provided with steel bell and spigot rings.
- E. All precast manhole components shall be of approved design and of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact. Manhole bases shall have two cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall not be less than 5-inches. Concrete top slabs shall not be less than 8-inches thick.
- F. Lifting holes, if used in manhole components, shall be tapered, and no more than two shall be cast in each section. Tapered, solid rubber plugs shall be furnished to seal the lifting holes. The lifting holes shall be made to be sealed by plugs driven from the outside face of the section only.
- G. The point of intersection (P.I.) of the sewer pipe centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in the floor of each manhole base and protruding approximately 1-inch above the finished floor of the base.
- H. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.
- I. The barrel of the manhole shall be constructed of various lengths of riser pipe manufactured in increments of one foot to provide the correct height with the

fewest joints. Openings in the barrel of the manholes for sewers or drop connections will not be permitted closer than one foot from the nearest joint. Special manhole base or riser sections shall be furnished as necessary to meet this requirement.

- J. A precast or cast-in-place slab or precast eccentric cone, as shown or approved, shall be provided at the top of the manhole barrel to receive the cast iron frame and cover.

2.2 MASONRY MANHOLES AND STRUCTURES

- A. Masonry manholes and structures, where shown or otherwise approved by ENGINEER, shall conform to the following:
 - 1. Brick: Brick shall conform to the requirements of ASTM C 32, Grade SS for sewer brick and Grade MS for manhole brick.
 - 2. Concrete Blocks: Concrete blocks shall be machine-made, solid segmental blocks not less than 8-inches wide and shaped so that the completed structure in which they are used will conform to the details shown or otherwise approved. Blocks shall be of compact texture and like blocks shall be uniform in shape and size.
 - 3. Concrete blocks shall conform to ASTM C 139. Testing of blocks shall be done in accordance with the requirements of ASTM C 140.
 - 4. Mortar: The mortar shall be composed of portland cement, hydrated lime, and sand, in which the volume of sand shall not exceed three times the sum of the volumes of cement and lime.
 - 5. Cement shall be Type II portland cement as specified for concrete masonry.
 - 6. Hydrated lime shall be Type S conforming to ASTM C 207.
 - 7. The sand shall comply with the Specifications for "Fine Aggregate" for concrete, except that all of the sand shall pass a No. 8 sieve.

2.3 MISCELLANEOUS METALS

- A. Metal frames and covers and similar required items shall be provided as shown and in accordance with Division 05, Metals.

2.4 DROP CONNECTIONS

- A. Drop connections for manholes and structures shall be constructed where shown or directed by the ENGINEER and shall conform to the design and details shown. Pipe and fittings shall be ductile iron, reinforced concrete, or vitrified clay as shown or otherwise approved. Concrete for pipe encasement shall be Class "B" as specified under Section 03 30 00, Cast-In-Place Concrete. Concrete shall be bonded to manhole in the manner shown or otherwise approved by ENGINEER.

2.5 VORTEX FLOW INSERTS

- A. Definitions:
 - 1. Vortex Flow Insert (VFI) – A hydraulic drop that uses a manufactured VFI, as Specified in these documents. The VFI is comprised of a top form, drop shaft, and energy dissipation chamber for installation within a manhole, vault or other structure. The primary functions of VFIs are to prevent the

release of H₂S and other sewage gases and absorb and dissipate the kinetic energy of the wastewater flowing through the structure.

2. MGD- Million gallons per day
- B. Vortex low Insert(VFI) – Furnish and install two (2) manufactured VFI units, each with flow capacity of 1.7 MGD and recommended mounting and connection materials, conforming to AWWA C-900, AWWA C-905, and ASTM C-581 standards. The VFI is comprised of a top form, shaft, and dissipation chamber. Provide Vortex Flow Insert (VFI) units by IPEX Inc. or approved equal.
 1. Performance – The VFI will function effectively for flows between 15% and 115% of rated capacity unless otherwise specified.
- C. Mounting System – Furnish and install a mounting system to secure the structure in place. All fasteners and supports, including straps, mounting hardware and supports shall meet the following requirements.
 1. Materials of Construction – The anchors, strapping and other mounting hardware shall be of 316 stainless steel construction.
 2. Structural Design Basis – Horizontal Support: The mounting system must have capability to withstand a horizontal force of 40 lbf resulting from the flow entering the VFI.

PART 3 - EXECUTION

3.1 LAYING MASONRY

- A. Brick shall be satisfactorily wet when being laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The joints shall not be wider than 3/8-inch, except when the bricks are laid radially, in which case the narrowest part of the joint shall not exceed 1/4-inch. Masonry work shall be kept moist for a period of three days after completion, and precautions shall be taken to prevent freezing during cold weather.
- B. For concrete block, the vertical keyways shall be completely filled with mortar.
- C. Each grading ring shall be laid in a full bed of mortar and shall be thoroughly bonded.

3.2 PLASTERING

- A. The outside of brick manholes and structures, brick stacks and grading rings shall be neatly plastered with 1/2-inch of cement mortar as the Work progresses.

3.3 MANHOLE BASES

- A. Cast-in-place bases shall be placed on suitable foundations after the pipes are laid. They shall be cast monolithically to an elevation at least 12-inches above the top of the highest pipe entering the manhole, except where a drop connection is to be installed. Base, walls and bottom shall be at least of the thickness shown and reinforced to withstand the loads to be expected. Connections for sewer pipes shall conform to the details shown in the final project plans.

- B. Precast bases shall be set on a crushed stone or crushed gravel foundation as shown. Precast bases shall be set at the proper grade and carefully leveled and aligned.

3.4 PRECAST MANHOLE SECTIONS

- A. Set sections vertical with steps and sections in true alignment. The base of the bell or groove end at joints between components shall be buttered with 1:2 cement-sand mortar to provide a uniform bearing between components. All joints shall be sealed with cement mortar inside and out and troweled smooth to the contour of the wall surface. Raised or rough joint finishes will not be accepted.
- B. Install sections, joints and gaskets in accordance with manufacturers recommendations.
- C. Lifting holes shall be sealed tight with a solid rubber plug driven into the hole from the outside of the barrel and the remaining void filled with 1 to 2 cement-sand mortar.

3.5 MANHOLE CHANNELS

- A. All invert channels through manholes and structures shall be constructed of Class "A" concrete. Channels shall be properly formed to the sizes, cross sections, grades and shapes shown or as ordered. Benches shall be built up to the heights shown or as directed by the ENGINEER and given a uniform wood float finish. Care shall be taken to slope all benches for proper drainage to the invert channel.

3.6 GRADING RINGS

- A. Grading rings or brick stacks shall be used for all precast and masonry manholes and structures, where required. Stacks or grade rings shall be a maximum of 12-inches in height, constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the stack or grade rings shall be such as required to bring the manhole frame to the proper grade.
- B. Each grade ring shall be laid in a full bed of mortar and shall be thoroughly bonded.
- C. Brick work shall be as specified in Article 2.2 and Article 3.1, above.

3.7 STUBS FOR FUTURE CONNECTIONS

- A. As shown or required for connections, cast iron sleeves, bell end tile, ductile iron or reinforced concrete pipe stubs with approved watertight plugs shall be installed in manholes and structures. Where pipe stubs, sleeves or couplings for future connections are shown or directed by the ENGINEER, CONTRACTOR shall provide all materials and labor in order to complete the Work.

3.8 GRADING AT MANHOLES AND STRUCTURES

- A. All manholes and structures in unpaved areas shall be built, as shown or directed by the ENGINEER, to an elevation higher than the original ground. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around manholes to the level of the upper rim of the manhole frame, and the surface evenly graded on a 1 to 5 slope to the existing surrounding ground, unless otherwise shown or directed by the ENGINEER. The slope shall be covered with 4-inches of topsoil, seeded and maintained until a satisfactory growth of grass is obtained.
- B. Manholes and structures in paved areas shall be constructed to meet the final surface grade. In paved areas on State Highways, all manholes and structures shall be 1/2-inch below final wearing surfaces. Manholes and structures shall not project above finished roadway pavements to prevent damage from snowplows.
- C. CONTRACTOR shall be solely responsible for the proper height of all manholes and structures necessary to reach the final grade at all locations. CONTRACTOR is cautioned that ENGINEER'S review of Shop Drawings for manhole components will be general in nature and CONTRACTOR shall provide an adequate supply of random length precast manhole riser sections to adjust any manhole to meet field conditions for final grading.

3.9 MANHOLE WATERTIGHTNESS

- A. All manholes and structures shall be free of visible leakage. Each manhole shall be tested for leaks and inspected, and all leaks shall be repaired in a manner subject to ENGINEER'S approval. Manhole testing shall conform to the requirements of Section 33 05 05, Buried Piping Installation.

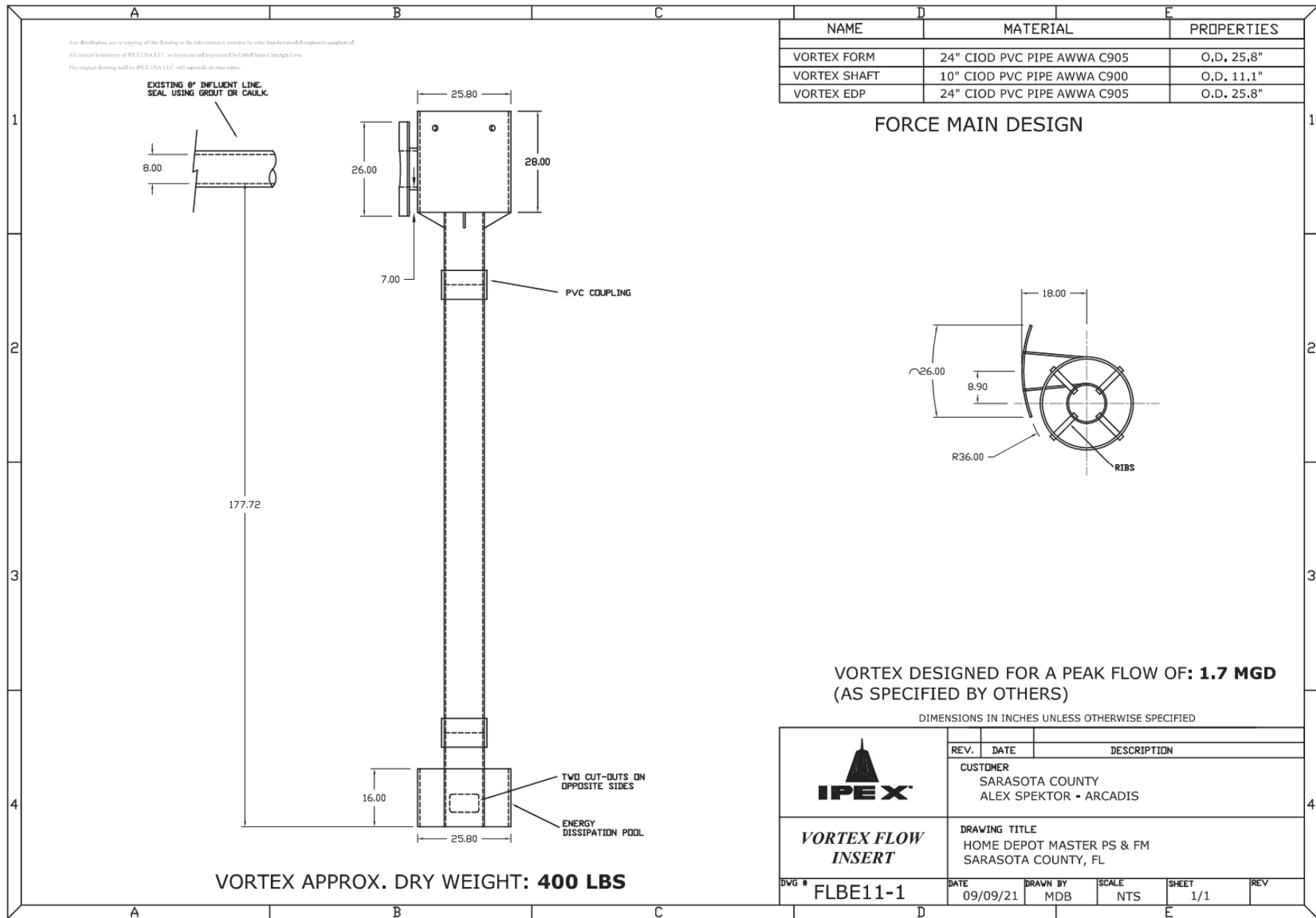
3.10 FLEXIBLE PIPE JOINT AT MANHOLE BASE

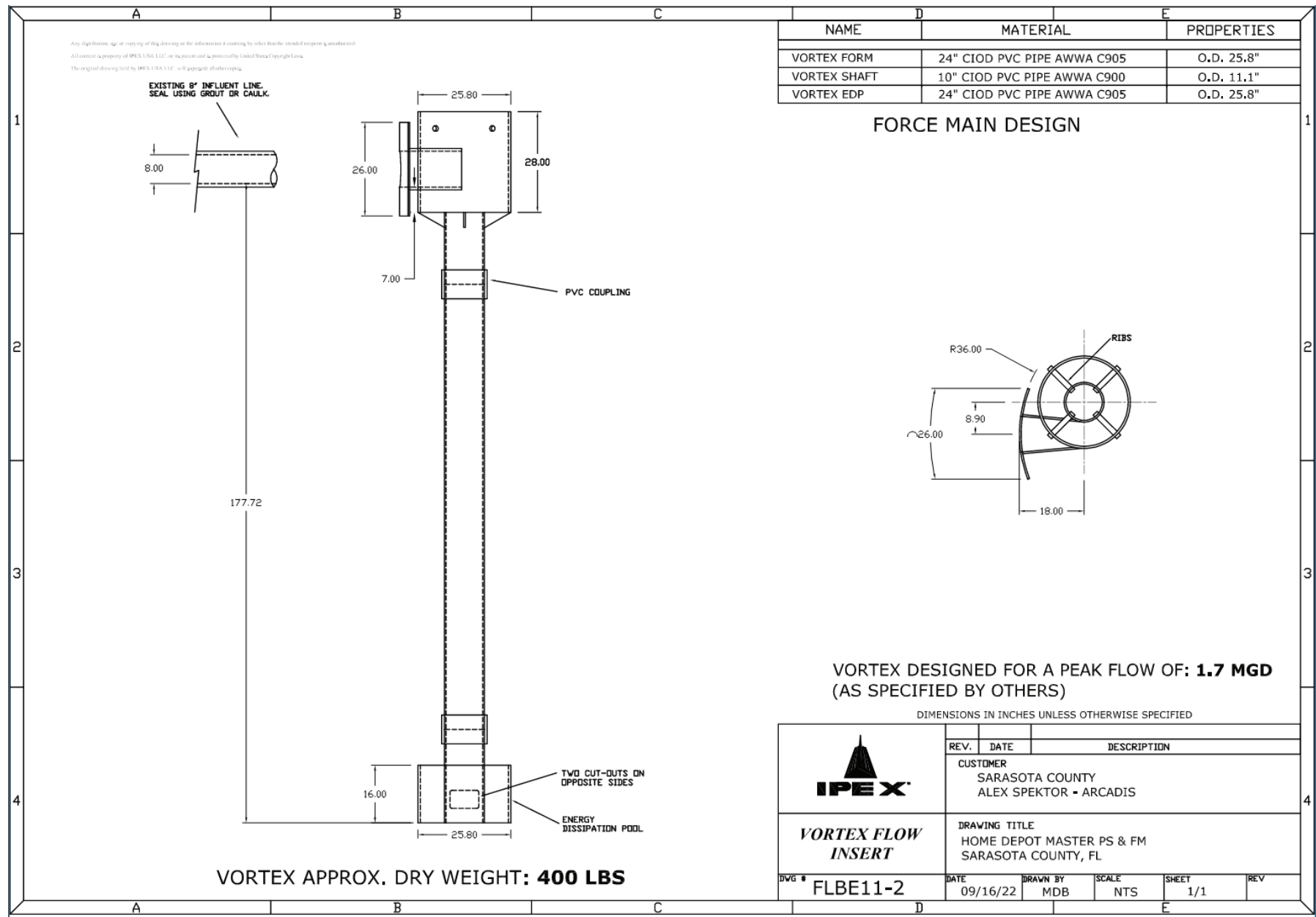
- A. An approved flexible joint shall be provided between each pipe entering and exiting the manhole. This may be accomplished by the installation in the manhole base of the bell end of a pipe or by other means subject to approval of ENGINEER. Joints shall be similar to the approved pipe joints. The joint into the manhole base shall be completely watertight.

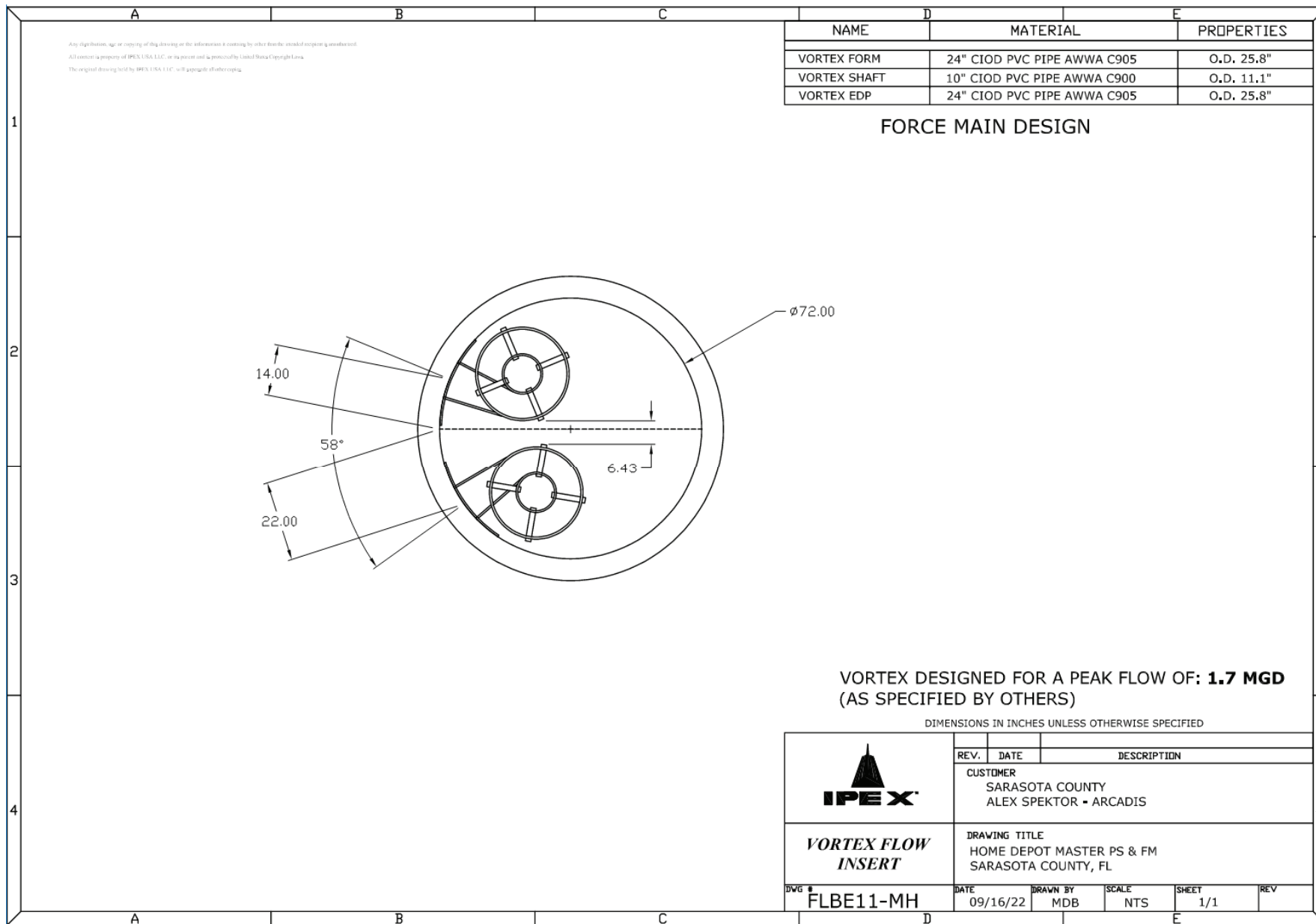
3.11 VORTEX FLOW INSERT INSTALLATION

- A. Install VFI and associated mounting system according to the plans and specifications, and in general conformance to the manufacturer's recommendations. This includes, but is not limited to aligning, anchoring, spacer placement, and use of temporary and permanent support systems. Provide a watertight connection between the device and influent pipe through use of non-shrink sealant or grout, as approved by the engineer.
- B. The quantities of vortex energy dissipation inserts will be measured on a unit basis (ea.).
- C. See attached cut sheets for detailed design of VFI

+ + END OF SECTION + +







SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
 - a. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections or other contracts.
 - b. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
 - c. Work on or affecting existing exposed piping.
 - d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
 - e. Supports, restraints, and other anchors.
 - f. Field quality control, including testing.
 - g. Cleaning and disinfecting.
 - h. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.
2. Coordinate with appropriate piping Sections of Division 40, Mechanical.

C. Related Sections:

1. Section 09 91 00, Painting.
2. Section 40 05 07, Pipe Hangers and Supports.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings
2. ASME Boiler and Pressure Vessel Code.
3. ASME B31.3, Process Piping.
4. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.

5. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
6. ASTM B32, Specification for Solder Metal.
7. ASTM D4161, Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
8. ASTM D4174, Standard Practice for Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
9. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
10. AWS D1.1/D1.1M, Structural Welding Code-Steel.
11. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
12. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
13. ANSI/AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
14. ANSI/AWWA C606, Grooved and Shouldered Joints.
15. ANSI/AWWA C651, Disinfecting Water Mains.
16. AWWA M9, Concrete Pressure Pipe.
17. AWWA M11, Steel Pipe - A Guide for Design and Installation.
18. AWWA M23, PVC Piping - Design and Installation.
19. AWWA M41, Ductile-Iron Pipe and Fittings.
20. AWWA M45, Fiberglass Pipe Design.
21. AWWA M55, PE Pipe - Design and Installation.
22. SAE J1227, Method for Assessing the Cleanliness Level of New Hydraulic Fluid.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including:
 - a. Sarasota County Public Utilities
 - b. Florida Department of Transportation
 - c. Florida Department of Environmental Protection

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Detailed drawings in plan and, as applicable, section.
 - b. Details of piping, valves, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping, structures, equipment, and appurtenances.
 2. Testing Plans, Procedures, and Testing Limitations
 - a. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.
- B. Informational Submittals: Submit the following:
 1. Certificates:
 - a. Submit a certificate, signed by manufacturer of each product, certifying that product complies with applicable referenced standards.
 2. Source Quality Control Submittals:
 - a. Submit copies of testing report for each test.

3. Site Quality Control Reports:
 - a. Submit copies of testing report for each test.
- C. Closeout Submittals: Submit the following:
 1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
 - b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
 - c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
 - d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery:
 1. Deliver products to Site to ensure uninterrupted progress of the Work.
 2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
 3. Conform to requirements of Section 01 65 00, Product Delivery Requirements.
- B. Storage:
 1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.
 2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.
 3. Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements.
- C. Handling:
 1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.
 2. Avoid unnecessary handling of pipe.
 3. Keep pipe interiors free of dirt and foreign matter.
 4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.
 5. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 40, Process Integration.
- B. Markings and Identification:
 - 1. Pipe Markings:
 - a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.
- C. Appurtenances: Provide products that comply with:
 - 1. Section 40 05 07, Pipe Hangers and Supports.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 - 1. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.
 - 2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
 - 3. Provide pipe manufacturer's installation specialist at Site as specified on this Section.
- B. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
 - 1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
 - 2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
 - 3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
 - 4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.
- C. Piping Installation:
 - 1. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41.
 - b. Fiberglass Reinforced Plastic Pipe: AWWA M45
 - c. Polyethylene Pipe: AWWA M55

2. Install straight runs true to line and elevation.
3. Install vertical pipe truly plumb in all directions.
4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by the ENGINEER.
5. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
6. Install piping to leave all corridors, walkways, work areas, and similar spaces unobstructed. Unless otherwise approved by ENGINEER provide a minimum headroom clearance under piping and pipe supports of 7.5 feet. Clearances beneath piping shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.
7. Protect and keep clean interiors, fittings, and valves of pipe that will convey potable water, chemicals, and other pipe designated by ENGINEER.
8. Cutting: Cut pipe from measurements verified at Site. Field cut pipe, where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.

D. Jointing Pipe:

1. General:
 - a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
 - b. Cut piping accurately and squarely and install without forcing or springing.
 - c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
 - d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
2. Ductile Iron Mechanical Joint Pipe:
 - a. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
 - b. Lubricate plain end and gasket with soapy water or pipe manufacturer's recommended pipe lubricant, per ANSI/AWWA C111, just prior to slipping gasket onto plain end of joint assembly.
 - c. Place gland on plain end with lip extension toward plain end, followed by gasket with narrow edge of gasket toward the plain end.
 - d. Insert pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
 - e. Push gland toward socket and center it around pipe with the gland lip against the gasket.
 - f. Insert bolts and hand tighten nuts.
 - g. Deflect joint only after assembled when approved by ENGINEER.
 - h. Make deflection after joint assembly, if approved by ENGINEER, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. Bolt torque shall be:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

3. Ductile Iron Push-On Joint Pipe:
 - a. Prior to assembling joints, thoroughly clean with a wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.
 - b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold temperatures.
 - c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.
 - d. Immediately prior to joint assembly, apply a thin film of pipe manufacturer's recommended lubricant to surface of gasket that will come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.
 - e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with the rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with the base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.
 - f. Maintain an adequate supply of gaskets and joint lubricant at Site when pipe jointing is in progress.
4. Ductile Iron Proprietary Joints:
 - a. Pipe that utilizes proprietary joints for restraint specified in Section 40 05 19, Ductile Iron Process Pipe, or other such joints, shall be installed in accordance with manufacturer's instructions.
5. Ductile Iron and Steel Flanged Joints:
 - a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
 - b. Tighten bolts in a sequence that provides equal distribution of bolt loads.

- c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.
 - d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
 - e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
 - f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating specified in Section 09 91 00, Painting, for material of pipe and fittings being joined.
- 6. Mechanical Coupling Joints:
 - a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings used.
 - b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with a wire brush to remove foreign matter.
 - c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
 - d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove the clamps from the coupling. Slide the coupling over the plain ends of the pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with a torque wrench to torque recommended by manufacturer.
- E. Installing Valves and Accessories:
 - 1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.
 - 2. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the flow measuring device manufacturer, unless specific location dimensions are shown.
 - 3. Position swing check valves and butterfly valves so that they do not conflict with upstream and downstream elements of the piping system.
- F. Transitions from One Type of Pipe to Another:
 - 1. Provide all necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

- G. Closures:
 - 1. Provide closure pieces, such as blind flanges and caps, shown or required to complete the Work.

3.3 THRUST RESTRAINT

- A. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.
- B. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Exposed Piping Schedule at end of this Section.
- C. Restrained Pipe Joints:
 - 1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with a proprietary restrained joint system as specified in Section 40 05 19. Ductile iron pipe, lugs, and tie rods, or other joint restraint systems approved by ENGINEER. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
- D. Work on Existing Pipelines:
 - 1. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.

3.4 PAINTING

- A. Field painting shall conform to Section 09 91 00, Painting.

3.5 FIELD QUALITY CONTROL

- A. Testing, General:
 - 1. Test all piping.
 - 2. Notification:
 - a. Notify ENGINEER at least 48 hours prior to testing.
 - b. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
 - 3. Conduct all tests in presence of ENGINEER.
 - 4. Remove or protect pipeline-mounted devices that could be damaged by testing.
 - 5. Provide all apparatus and services required for testing, including:
 - a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
 - 6. Provide air if an air test is required and power if pumping is required.
 - 7. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for

hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.

8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of ENGINEER or OWNER. Repair of existing piping will be paid as extra work unless otherwise specified.

B. Test Schedule:

1. Refer to the Exposed Piping Schedule for type of test required and required test pressure.
2. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Exposed Piping Schedule:
 - a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires a separate test.
 - b. Disinfect for bacteriological testing piping that conveys potable water.
4. Test Pressure:
 - a. Use test pressures listed in Exposed Piping Schedule.
 - b. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:

1. Preparation for Testing:
 - a. For ductile iron piping follow procedures described in AWWA Manual M41. A wetting period is not required for pipe that is not cement mortar-lined.
 - b. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
2. Test Procedure:
 - a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.
 - b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
 - c. Examine joints and valves, and make repairs to eliminate visible leakage.
 - d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
 - e. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
 - f. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid

- as required to maintain pressure within five psig of required test pressure.
 - g. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen minute intervals for duration of test.
 - 3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:
 - a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
 - b. Rates based on formula or table in AWWA Manual M41:
 - 1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:
 - a) Bell and spigot and push-on joints.
 - b) Mechanical joints.
 - c) Bolted sleeve type couplings.
 - d) Grooved and shouldered couplings.
 - c. Rates based on make-up allowance in AWWA Manual M9:
 - 1) Prestressed concrete cylinder pipe and other types of concrete pipe joined with O-ring rubber gasket sealing members.
 - d. Rates based on formula or table in ANSI/AWWA C605:
 - 1) Plastic pipe joined with O-ring gasket sealing members.
- D. Exfiltration Testing:
- 1. Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment.
 - 2. Before measuring leakage, allow fluid to wet pipe interior for the following period:
 - a. Concrete Pipe: 48 hours.
 - b. Cement Mortar-lined Pipe: 24 hours.
 - c. Other Pipe: Wetting period not required.
 - 3. Provide a minimum hydrostatic head during test of two feet above highest point of pipe segment tested.
 - 4. Add fluid from a test container or from a metered supply as required to maintain the test water level within three inches of the test head throughout the test.
 - 5. Test duration shall be at least two hours.
 - 6. Allowable Leakage Rates:
 - a. Leakage is defined as the quantity of fluid that must be supplied to pipe segment tested to maintain the hydrostatic head within three inches of test head during the test after pipe has been filled and exposed to required wetting period, plus the quantity required to refill to original head at end of test.
- E. Process Air Pipe Testing:
- 1. General:
 - a. Required test pressure is listed in Exposed Piping Schedule.
 - 2. Preparation for Testing:
 - a. Provide temporary tie rods at expansion joints as required.
 - b. Verify that pipe supports, where present, are secure.

- c. Test one pipe segment at a time. Use temporary blind flanges and isolators as required.
 - d. Install corporation cocks for filling and relieving air. Provide temporary automatic pressure relief valve and pressure gauge with range suitable for test pressure.
 - 3. Test Procedure:
 - a. Pressurize pipe segment being tested with air to the required test pressure. Maintain pressure for at least two hours.
 - b. Apply a soapy water solution to all joints to check for leakage, indicated by presence of bubbles, while test pressure is maintained.
 - c. Allowable Leakage: Zero
 - 4. Repair and retest pipelines that fail the test.
 - 5. After testing is complete remove temporary measures provided for testing and provide Type 304 stainless steel threaded plugs at taps used for testing.
- F. Examination of Welds:
- 1. Personnel performing examination of welds shall be qualified to at least Level II, in accordance with ASNT SNT-TC-1A.
 - 2. Conform to ASME Boiler and Pressure Vessel Code Section V and applicable articles for examination of welds.
 - 3. Visually examine all welds, Category D Fluid Service, in conformance with ASME B31.3.
 - 4. Examine at least ten percent of welds using liquid penetrant examination.
 - 5. If a defect is detected, all welds shall be examined by liquid penetrant examination.
 - 6. At conclusion of liquid penetrant examination, remove penetrant test materials by flushing, washing, or wiping clean with applicable solvents.

3.6 CLEANING AND DISINFECTION

A. Disinfection

- 1. Water for initial flushing, testing, and disinfection will be furnished by OWNER. CONTRACTOR shall provide all temporary piping, hose, valves, appurtenances, and services required. Cost of water required for re-disinfection will be paid by CONTRACTOR to OWNER at the water utility's standard rates.

3.7 EXPOSED PIPING SCHEDULE

- A. The schedules listed below, following the "End of Section" designation, are a part of this Specification section.
 - 1. Table 40 05 05-A, Exposed Piping Schedule.

+ + END OF SECTION + +

**TABLE
40 05 05-A, EXPOSED PIPING SCHEDULE**

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
SFM	10	DI	CE	P	350	Flg	HYD (50)	
SFM	8	DI	CE	P	350	Flg	HYD (50)	

The following abbreviations are used in the Exposed Piping Schedule.

A. Service Abbreviations

Service	Abbrev.	Service	Abbrev.
Sanitary Force Main	SFM	Overflow	OF
Raw Water	RW	Centrate	CEN
Potable Water	PW	Filtrate	FILT
City Water	CW	Scum	SCUM
Non-Potable Water	NPW	Primary Sludge	PS
Plant Effluent Water	PEW	Return Activated Sludge	RAS
Spray Water	SPW	Waste Activate Sludge	WAS
Backwash Water	BW	Thickened Sludge	TS
Hot Water Supply	HWS	Mixed Sludge	MS
Hot Water Return	HWR	Digested Sludge	DS
Influent	INF	Chlorine Solution	CLS
Effluent	EFF	Sodium Hydroxide (Caustic)	NAOH
Drain	DR	Sodium Hypochlorite	NAOCL
Process Air	PA	Polymer Solution	POLYS
Instrument Air	IA	Alum	AL
Digester Gas	DIG	Hydraulic Fluid	HF
Chlorine Gas	CLG	Fuel Oil	FO
Wastewater	WW	Lube Oil	LO

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Ductile Iron	DI		Polyvinyl Chloride	PVC
Cast Iron	CI		Chlorinated Polyvinyl Chloride	CPVC
Carbon Steel	CS		Polyethylene	PE
Stainless Steel	SS		High Density Polyethylene	HDPE
Copper	C		Fiberglass Reinforced Plastic	FRP
Prestressed Concrete Cylinder Pipe	PCCP			
Non-Prestressed Concrete Cylinder Pipe	CCP			
Steel Cylinder Pipe	SCP			

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Painted	P
Glass Lined	GL		Insulated	I
Ceramic Epoxy	CE		Galvanized	Galv
Fusion Bonded Epoxy Lined	FBEL			
Plastic Lined	PL			

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Bell and Spigot	BS		Flanged	Flg
Restrained Bell and Spigot	RBS		Butt Weld	BW
Push-on Joint	POJ		Lap Weld	LW
Restrained Push-on Joint	RPOJ		Butt Fusion Weld	BFW
Mechanical Joint	MJ		Solvent Weld	SW
Restrained Mech. Joint	RMJ		Sleeve-type Flexible Coupling	SLFC
Soldered	Sd		Split Flexible Coupling	SPFC
Brazed	Bz		Plasticized PVC Coupling	PPVC
Threaded	Thd		Grooved or Shouldered End Coupling	GSEC
			Flanged Adapter	FA

E. Test Abbreviations

Test	Abbrev		Test	Abbrev.
Hydrostatic Test (test pressure in psig)	HYD ()		Disinfection and Bacteriological Testing	DBT
Process Air Pipe Test (test pressure in psig)	PA ()		Examination of Welds	EW
Chlorine Pipe Test	CL		Exfiltration Test	EX
			No Test Required	NR

SECTION 40 05 07

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to design, furnish, and install all hangers, supports and appurtenances necessary to complete the Work.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the pipe hangers and supports Work.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 05 50 13, Miscellaneous Metal Fabrications.
 - 3. Section 09 91 00, Painting.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 575, Specification for Steel Bars Carbon, Merchant Quality, M-Grades.
 - b. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
 - 2. Federal Specification, (FS).
 - a. FS A-A-1192, Hangers, Pipe.
 - 3. Manufacturers Standardization Society of the Valve and Fittings Industry, (MSS).
 - a. MSS SP 58, Pipe Hangers and Supports-Materials, Design and Manufacture.
 - b. MSS SP 69, Pipe Hangers and Supports - Selection and Application.
 - 4. Underwriters' Laboratories, Inc., (UL).
 - a. UL 203, Pipe Hanger Equipment for Fire Protection Service.

1.3 QUALITY ASSURANCE

- A. Each type of pipe hanger or support shall be the product of one manufacturer.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single pipe hangers and supports manufacturer.
 - 2. The pipe hangers and supports equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.

3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pipe hangers and supports equipment manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Detailed drawings showing all hangers and supports for each piping system specified. Shop Drawings shall show location, installation, material, loads or forces, and deflection of all hangers and supports.
 - b. Each pipe system shall be analyzed for all loads and forces on the hangers and supports. Provide calculations of reaction forces to the structure to which they are fastened. Provide confirmation that hanger systems comply with support requirements and codes.
 - c. Submit and coordinate these with Shop Drawings required for all piping systems.
 2. Product Data:
 - a. Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP 58, MSS SP 69 and Federal Specification A-A-1192.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
- B. Storage and Protection:
 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store materials in covered storage off the ground and prevent condensation.
- C. Acceptance at Site:
 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Hangers and supports shall meet with the following requirements:

1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
3. Install hangers or supports at all locations where pipe changes direction.
4. All hangers and supports shall be capable of adjustment after placement of piping.
5. Different types of hangers or supports shall be kept to a minimum.
6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
9. Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

Pipe Size (inches)	Maximum Pipe Span ¹ (feet)			
	Steel	Copper	Plastic ²	Cast/Ductile Iron ⁴
4	12	12	5	12 feet for pressure pipe
6	12	12	5	
8	12	12	5	
10	12	-	5	
12	12	-	10	
14	12	-	-	
16	12	-	-	
18	12	-	-	10 feet for soil pipe
20	12	-	-	
24	12	-	-	

¹Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

²Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.

³Continuous means pipe shall be in unistrut or similar channel.

⁴ Pipe hanger and support selection shall be as shown and in this Section.

10. Maximum support spacing, unless otherwise shown for plastic pipe at ambient temperature, shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130°F shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended there from.

13. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless steel hangers or supports.
 14. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
 15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
 16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.
- B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
1. $\Delta L = L \times \Delta T \times \alpha$
 - a. Where ΔL = pipe length change (inches).
 - b. L = pipe length between anchors (inches).
 - c. ΔT = 100 (F).
 - d. α = coefficient of thermal expansion (inches/inches/F).
 2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.
 3. Expansion compensation shall be achieved via expansion joints specified in the drawings and expansion joint table in the drawings.

2.2 HANGERS AND SUPPORTS

- A. Hangers and supports where shown shall be in accordance with detail drawings. Hangers and supports not shown shall be in accordance with MSS SP 58.
- B. Manufacturers: Provide one of the following:
- Manufacturers
1. Anvil International, Inc.
 2. Elcen.
 3. B-Line.
 4. Unistrut Corporation.
 5. Or equal.
- C. Chemical Piping Systems:
1. All pipe supports and fasteners shall be glass fiber-reinforced plastic with a flame spread rating of 25, in accordance with ASTM E 84.
 2. Materials shall be manufactured by either the pultrusion or extrusion process.
 3. All pipe supports shall have a surface veil over 100 percent of the surface which, along with a filler system, shall protect against degradation from ultra-violet light.
 4. All fasteners shall be manufactured from long glass fiber-reinforced polyurethane to ensure strength and corrosion resistance.
 5. All-thread rods shall be made from vinylester resin.
 6. Manufacturers: Provide products of one of the following:
 - a. Unistrut Company.
 - b. Or equal.

2.3 ACCESSORIES

- A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.
- B. Concrete Inserts:
 - 1. Non continuous concrete inserts shall be MSS SP 58 malleable Type 18.
 - 2. Concrete inserts shall be of the continuous type capable of supporting 40 pounds per foot of insert as shown.
 - 3. Manufacturers: Provide products of one of the following:
 - a. Unistrut Corporation, Wayne, Michigan.
 - b. Elcan Metal Products, Company, Franklin Park, Illinois.
 - c. B-Line.
 - d. Anvil International, Inc.
 - e. Or equal.
- C. Steel Beam Clamps:
 - 1. Steel beam clamps shall be of malleable iron and conform to MSS SP 58.
- D. Inserts for Pipe Insulation:
 - 1. Insulated pipe, larger than 1-1/2-inches in diameter, shall be supported by a rigid insert to protect the insulation. A steel metal saddle of sufficient gauge to carry the weight of the pipe and its fluid without deforming shall extend 2-inches minimum on each side of the rigid insert. The joints between insert and insulation shall be sealed before saddle is installed. Sizes up to 6-inches IPS shall be MSS SP 58, Type 40, and for sizes over 10-inches shall be MSS SP 58, Type 39.
- E. Brackets:
 - 1. Brackets for wall mounting shall conform to MSS SP 58 Type-32 for medium welded steel bracket; Type-33 for heavy-welded steel bracket; Type-34 for side beam support.
- F. Fabricated Pipe Rack:
 - 1. A large number of pipes shall be supported and anchored to the fabricated pipe rack. Clamps, rollers, and supports for piping shall conform to the general requirements of MSS SP 69.

2.4 PAINTING

- A. Clean and prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09 91 00, Painting.
- B. Field painting shall conform to the requirements of Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.

- B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.
- C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
 - 1. Temperature differential specified in this Section.
 - 2. Support piping independently so that equipment is not stressed by piping weight or expansion.
 - 3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. Instrumentation tubing shall be supported in steel or aluminum troughs with covers. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
 - 4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.
 - 5. Maximum spacing for horizontal piping:
 - a. Steel 1-Inch and Smaller: Seven feet.
 - b. Steel 1-1/2-Inch and Larger: Ten feet.
 - c. Brass or Copper 3-Inch and Smaller: Seven feet.
 - d. Brass or Copper 4-Inch and Larger: Ten feet.
 - e. Additional supports at:
 - 1) Change in direction.
 - 2) Branch piping and runouts over five feet.
 - 3) Concentrated loads due to valves, strainers or other similar items.
 - f. Maximum support spacing for plastic pipe at ambient temperature shall be one-half the above values.
 - 6. Hanger types for horizontal piping, except as noted and shown:
 - a. Forged steel adjustable clevis type, rod support for all services.
 - b. Slide Bases:
 - 1) Pipe stand, brackets, trapeze or other equivalent structural support.
 - 2) For piping 2-inches or larger.
 - c. For pipe and covering provide:
 - 1) Saddles for rollers or slide bases.
 - 2) Protective shields or saddles for all other types of supports.
 - d. Threaded Steel Rods:
 - 1) Two inch vertical adjustment with two nuts each end for positioning and locking.
 - 2) Size hanger rods according to the schedule below, unless otherwise noted:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

- 3) For Double Rod Hangers: One size smaller than above.

- 4) Connection to Structure for Piping to 2-Inches: Concrete inserts, or expansion shields in shear into sides of beams.
 - 5) Connection to Structure for Piping 2-1/2-Inch or Larger: Concrete inserts, beam clamps or suitable bridging.
 - 7. Vertical Piping:
 - a. Base Support: Base elbow or welded equivalent.
 - 1) Bearing plate on structural support.
 - b. Guides not to exceed:
 - 1) 25 feet for piping to 2-inches.
 - 2) 36 feet for piping 2-1/2-inches or larger.
 - c. Top Support:
 - 1) Special hanger or saddle in horizontal connection.
 - 2) Provisions for expansion.
 - d. Intermediate Supports: Steel pipe clamp at floor.
 - 1) Bolted and welded to pipe.
 - 2) Extension ends bearing on structural steel or bearing plates.
 - e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.
 - 8. Insulated Piping:
 - a. Horizontal Pipe Shields at Supports:
 - 1) Minimum 120 degree arc.
 - 2) Length equal to diameter of insulation 12-inch minimum.
 - 3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.
 - b. Vertical Pipe Shields at Guides:
 - 1) Full 360 degree arc, securely banded.
 - 2) Length equal to diameter of insulation, 12-inch minimum.
 - 3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.
- D. Install items to be embedded before concrete placement.
- E. Fasten embedded items securely to prevent movement during concrete placement.
- F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations.
- G. Adjust hangers and supports and place grout for concrete supports to bring pipelines to specified elevations.
- H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

+ + END OF SECTION + +

SECTION 40 05 19

DUCTILE IRON PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
2. Extent of piping is shown on the Drawings. Piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.

C. Related Sections:

1. Section 31 23 00, Excavation and Fill.
2. Section 09 91 00, Painting.
3. Section 33 05 05, Buried Piping Installation.
4. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
3. ASTM A193, Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
6. ASTM A354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
8. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
9. ASTM C283, Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
10. ASTM D714, Test Method for Evaluating Degree of Blistering of Paints.
11. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
12. ASTM D5162, Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates.
13. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
14. ASTM G14, Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
15. ASTM G62, Test Methods for Holiday Detection in Pipeline Coatings.

16. ASTM G95, Test Methods for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
17. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
18. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
19. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
20. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
21. ANSI/AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings for Water Service.
22. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.
23. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
24. ANSI/AWWA C606, Grooved and Shouldered Type Joints.
25. European Standard (EN), EN 598: Ductile Iron Pipe, Fittings, Accessories and Their Joints for Sewerage Applications.
26. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
27. NACE RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
28. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
29. NSF/ANSI 61, Drinking Water System Components - Health Effects.
30. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
31. SSPC Painting Manual, Volume 1, Para. XIV.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:

- a. Manufacturer shall have a minimum of five years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
- b. Lining and coating products shall be manufactured by a firm with a minimum of five years successful experience in protecting pipelines exposed to the specified service conditions , and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
- c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.

B. Supply and Compatibility:

1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.

2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.
 3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
 4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.
- C. Regulatory Requirements:
1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following with Shop Drawings required under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation:
1. Shop Drawings:
 - a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.
 2. Product Data:
 - a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Ductile iron pipe and fitting manufacturer and manufacturer and applicator of lining and coating, as specified, shall mutually determine recommended surface preparation and application methods, and provide written verification of mutually selected method in the submittals.
 3. Samples:
 - a. Submit Sample of pipe and fitting with each type of lining, for use at the Site to verify continuity, surface gloss, and color, as applicable, via visual inspection.
 4. Test Procedures: For linings and coatings in pipe and fittings.
- B. Informational Submittals: Submit the following:
1. Certificates:
 - a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
 - b. Submit certificate signed by applicator of the linings and coatings stating that product to be applied conforms to applicable referenced standards and that the applicator shall conform to the Contract Documents.
 2. Source Quality Control Submittals:
 - a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
 - b. Lining and coating test coupons.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
- B. Handling of Pipe and Fittings Lined with Ceramic Epoxy, Fusion Bonded Epoxy, or Glass: Lifting devices shall not come into contact with lined surfaces. Use hooks, forks, chains, straps, and other lifting devices only on exterior of pipe and fittings. Pipe and fittings with damaged lining shall be replaced regardless of cause of damage.
- C. Handling of Fittings Coated with Fusion Bonded Epoxy: Hooks, forks, chains, straps, and other lifting devices shall be rubber-coated and be used only on exterior of fittings in manner to avoid damaging coating. If coating becomes damaged, notify pipe and coating manufacturer to determine if repair of damaged area or re-coating is required. Perform repairs using recommended procedures and materials provided by manufacturer, as accepted by ENGINEER. Pipe and fittings requiring re-coating shall be removed from Site and returned to manufacturer's facility. Repaired or re-coated pipe and fittings shall comply with requirements of this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. General:
 - 1. Piping systems shall be suitable for their intended use.
 - 2. Joints shall be as specified in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by ENGINEER.
- B. Ductile Iron Pipe, Joints, and Fittings:
 - 1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
 - a. Pressure Rating: As specified in piping schedule in Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for 3-inch to 54-inch diameter pipe.
 - 2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
 - a. Pressure Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. .
 - b. Special Thickness Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.
 - 3. Pipe Joints:
 - a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 40 05 05, Exposed Piping Installation.
 - 1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch thick, ring or full-face as required for the pipe, of synthetic rubber compound containing not less than 50 percent by volume

- nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.
- 2) Bolts: Comply with ANSI B18.2.1.
 - a) Exposed: ASTM A307, Grade B.
 - b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex, Type 316 stainless steel.
 - 3) Nuts: Comply with ANSI B18.2.2.
 - a) Exposed: ASTM A563, Grade A, Heavy hex.
 - b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.
 - b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 1) Glands: Ductile iron.
 - 2) Gaskets: Plain tip.
 - 3) Bolts and Nuts: High strength, low alloy steel.
 - 4) Manufacturers: Provide products of one of the following:
 - a) Clow Water Systems Company
 - b) Atlantic States Cast Iron Pipe Company
 - c) Canada Pipe Company, Ltd.
 - d) McWane Cast Iron Pipe Company
 - e) Pacific States Cast Iron Pipe Company
 - f) Griffin Pipe Products Co.
 - g) American Cast Iron Pipe Co.
 - h) U.S. Pipe and Foundry Co.
 - i) Or equal.
 - c. Push-On Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure class or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 1) Gaskets: Vulcanized SBR, unless otherwise specified.
 - 2) Stripes: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.
 - 3) Products and Manufacturers: Provide one of the following:
 - a) Tyton or Fastite Joint by Clow Water Systems, Atlantic States Cast Iron Pipe Company, Canada Pipe Company, Ltd., McWane Cast Iron Pipe Company, Pacific States Cast Iron Pipe Company, and Griffin Pipe Products Company.
 - b) Fastite Joint by American Cast Iron Pipe Company.
 - c) Tyton Joint by U.S. Pipe and Foundry Company.
 - d) Or equal.
 - d. Grooved End Joints: Comply with ANSI/AWWA C606.
 - 1) Gaskets: Flush seal type designed for ductile iron that complies with or exceeds requirements of ASTM D2000
 - 2) Bolts and nuts: As specified for flanged joints.
 - 3) Unless otherwise specified, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
 - 4) Products and Manufacturers: Provide one of the following:

- a) Victaulic, Style 31.
 - b) Or equal.
 - e. Restrained Joints: Restrained push-on joints shall be capable of being deflected after full assembly. Field cuts of restrained pipe are not allowed without approval of ENGINEER.
 - 1) Products and Manufacturers: Provide restrained joints for mechanical joint piping by one of the following:
 - a) Megalug, Series 1100, by EBBA Iron Sales, Inc.
 - b) MJ Coupled Joint, by American Cast Iron Pipe Co.
 - c) MJ Field Lok, by U.S. Pipe and Foundry Co.
 - d) Or equal.
 - 2) Products and Manufacturers: Provide restrained joints for push-on joint piping by one of the following:
 - a) Super-Lock Joint Pipe, by Clow Water Systems, a division of McWane, Inc.
 - b) Lok-Ring Joint, or Flex-Ring Joint, by American Cast-Iron Pipe Company.
 - c) TR Flex Joint, by U.S. Pipe and Foundry Company.
 - d) Snap-Lok, by Griffin Pipe Products Company.
 - e) Or equal.
 - 4. Flanged and Push-On Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
 - a. Material: Ductile iron.
 - b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.
 - 5. Mechanical Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
 - a. Material: Ductile iron.
 - b. Glands: Ductile iron.
 - c. Pressure rating, gaskets, bolts, and nuts shall be as specified for mechanical joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of connected pipe.
- C. Lining, General:
- 1. See Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 2. Surface Preparation:
 - a. Initial Surface Inspection: Surface to be lined shall be inspected by pipe and fitting manufacturer and applicator, if applicator is other than pipe and fitting manufacturer. Inspecting parties shall inspect surface to be coated and mutually determine recommended surface preparation method.
 - b. Surface Preparation: Prepare surface in accordance with recommended method.
 - c. Finished Surface Inspection: Lining applicator shall inspect finished surface prior to application to determine acceptability. If surface is unacceptable, repeat surface preparation as necessary.

D. Ceramic Quartz-Filled, Amine-Cured Novalac Epoxy Lining:

1. Where specified in piping schedules included with Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation, pipe and fittings shall be factory lined with a quartz-filled, amine-cured, novalac, epoxy containing at least twenty percent by volume of ceramic quartz pigment.
2. Ceramic epoxy lining shall have a permeability rating of zero when tested according to Method A of ASTM E96, Procedure A, with a test duration of thirty days.
3. Conduct the following tests on coupons from factory lined ductile iron pipe:
 - a. ASTM B117 Salt Spray (scribed panel): Results to equal zero undercutting after two years.
 - b. ASTM G95 Cathodic Disbondment 1.5 volts at 77 degrees F: Results to equal no more than 0.5 mm undercutting after thirty days.
 - c. Immersion Testing rated using ASTM D714.
 - 1) Twenty Percent Sulfuric Acid: No effect after two years.
 - 2) Twenty-five Percent Sodium Hydroxide at 140 degrees F: No effect after two years.
 - 3) Distilled Water at 160 degrees F: No effect after two years.
 - 4) Tap Water at 120 degrees F (scribed panel): Zero undercutting after two years, with no effect.
4. Ceramic epoxy lining shall have abrasion resistance of no more than four mils loss after one million cycles, in accordance with ES EN 598, Section 7.8, Abrasion Resistance.
5. Within eight hours of surface preparation, interior of pipe and fittings shall receive 40 mils dry film thickness, utilizing method recommended by lining manufacturer that will comply with requirements of this Section. Number of coats applied shall be as recommended by lining manufacturer. Minimum substrate and ambient temperature for lining application shall be 40 degrees F.
6. Inspection and Certification:
 - a. Check all ductile iron pipe and fitting linings for thickness using magnetic film thickness gage in accordance with method in SSPC PA 2 Film Thickness Rating.
 - b. Test interior lining of pipe barrels and fittings for pinholes with non-destructive, 2,500-volt test. Defects found shall be repaired in accordance with lining manufacturer's recommendations prior to shipment from lining applicator's factory.
 - c. Mark each pipe and fitting with date of application and its numerical sequence of application.
7. Products and Manufacturers: Provide one of the following:
 - a. Protecto 401 Ceramic Epoxy.
 - b. Or equal.

E. Fusion Bonded Epoxy Lining for Fittings:

1. Where specified in piping schedules included with Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation, fittings shall factory lined with 100 percent solids, thermosetting, dry powder epoxy, in conformance with ANSI/AWWA C116.
2. Apply epoxy by utilizing method recommended by lining manufacturer, complying with requirements of this Section, with finished dry film thickness of not less than six mils, with exception of joint areas which shall receive thickness of not less than four mils for leak-proof joint. Heat and

- cure fittings in accordance with lining manufacturer's recommendations.
3. Source Quality Control: Coating material shall be applied to test coupon cut from section of a fitting approximately six-inch diameter and approximately four inches long, split lengthwise into two approximately equal sections. It is allowable to use fitting diameter other than the fitting diameter to be furnished for the Project. Surface preparation, application procedure, thickness, and curing parameters shall be the same for test coupon as for the actual fittings to be furnished. Perform the following tests on test coupon:
 - a. Coating material shall be scribed through to bare surface of fitting with an "X" across full length of test coupon. Immerse coupon in 150-degree F bath of distilled water and, after 500 hours, coupon shall show no signs of blistering or disbonding between lining and metal.
 - b. Test coupon shall be impact tested in accordance with ASTM G14 test method with 20 in.-lbf impact applied near center of concave section of test coupon, and shall show no signs of cracking or disbonding between lining and metal.
 4. Inspection and Certification:
 - a. All lined fittings shall be visually inspected and show no sign of blisters, cracks, or lack of coverage by lining.
 - b. Check lining thickness on all lined fittings using magnetic film thickness gauge in accordance with method in SSPC PA 2 Film Thickness Rating.
 - c. Holiday-test all lined fittings in accordance with ASTM D5162, NACE RP0188, and SSPC Painting Manual Vol. 1, Para. XIV, with low-voltage, wet sponge holiday detector. Repair methods and materials for holidays shall be as recommended by lining manufacturer and made prior to shipment from lining applicator's facility.
 5. Products and Manufacturers: Provide one of the following:
 - a. PipeClad 1500, by Valspar Corporation.
 - b. Or equal.

G. Specials:

1. Transition Pieces:
 - a. Provide suitable transition pieces (adapters) for connecting to existing piping.
 - b. Unless otherwise shown or indicated, expose existing piping to determine material, dimensions, and other data required for transition pieces.
2. Taps:
 - a. Provide taps where shown or required for small-diameter piping or instrumentation connections.
 - b. Provide corporation stops where shown or required.
 - c. Where pipe wall thickness or tap diameter will not allow engagement of full threads, provide tapping saddle with outlet joints conforming to requirements of Paragraph 2.1.B.3.a of this Section for four-inch through 12-inch diameter pipe, and Paragraph 2.1.B.3.b. for 14-inch through 54-inch diameter pipe.
 - d. For flanged connections on tapping saddle outlet branch, counterbore flange in accordance with MSS SP-60 dimensions. Inside diameter of outlet shall be 1/4-inch greater than nominal diameter.
3. Tangential Outlets:

- a. Provide tangential outlet fittings where shown or indicated.
- b. Flanged and grooved end joints are not allowed.

2.2 MARKING FOR IDENTIFICATION

- A. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
 - 1. Name or trademark of manufacturer.
 - 2. Weight, class or nominal thickness, and casting period.
 - 3. Country where cast.
 - 4. Year the pipe was produced.
 - 5. Letters "DI" or "Ductile" shall be cast or metal stamped
- B. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
 - 1. Flange manufacturer's mark, size, and letters "DI" cast or stamped on the flanges.
 - 2. Fabricator's mark if other than flange manufacturer.
 - 3. Length and weight.
- C. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify fittings with:
 - 1. Manufacturer's identification.
 - 2. Pressure rating.
 - 3. Nominal diameters of openings.
 - 4. Country where cast.
 - 5. Number of degrees or fraction of the circle on bends.
 - 6. Letters "DI" or "Ductile" cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

- A. General Coating Requirements:
 - 1. Coating types are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
- B. Exposed Pipe and Fittings:
 - 1. Surface Preparation:
 - a. Initial Surface Inspection: Pipe and fitting manufacturer and coating applicator shall inspect surface to be coated and mutually determine recommended NAPF 500-03 surface preparation method.
 - b. Surface Preparation: Prepare surface in accordance with recommended NAPF 500-03 method.
 - c. Finished Surface Inspection: Prepared surfaces shall be inspected by coating applicator prior to application to determine acceptability of finished surface. If surface is unacceptable, repeat surface preparation and re-application as necessary.
 - 2. After recommended surface preparation, prime coat exterior ferrous metal surfaces of pipe and fittings in the shop in accordance with Section 09 91 00, Painting.

3. Field painting shall comply with Section 09 91 00, Painting.
- C. Buried Pipe and Fittings:
1. Asphaltic Coating: Where specified in piping schedule in Section 33 05 05, Buried Piping Installation, coat pipe and fittings with an asphaltic coating approximately one-mil thick, in accordance with ANSI/AWWA C151, ANSI/AWWA C115, ANSI/AWWA C110, and ANSI/AWWA C153, as applicable.
 2. Fusion Bonded Epoxy Coating for Fittings:
 - a. When specified in piping schedule in Section 33 05 05, Buried Piping Installation, fittings shall be factory coated with 100 percent solids, thermosetting, dry powder epoxy, in conformance with ANSI/AWWA C116.
 - b. Apply coating utilizing a method, recommended by manufacturer that meets requirements of this Section, with finished dry film thickness of at least six mils, with exception of joint areas, which shall receive at least a four-mil dry film thickness coating. Heat and cure fittings in accordance with coating manufacturer's recommendations.
 - c. Source Quality Control: Cut a test coupon from coated fitting no less than six inches in diameter, and approximately four inches long, and split coupon lengthwise into two equal sections. Surface preparation, application procedure, thickness, and curing parameters shall be the same for test coupon as for Project fittings. Perform the following tests on test coupon:
 - 1) Scribe coating material through to bare surface of fitting with an "X" across full length of test coupon. Immerse coupon for 500 hours in 150-degree F bath of distilled water. Coating shall show no signs of disbondment or blistering.
 - 2) Test coupon shall be impact tested using ASTM G14 test method with 20 in.-lbf impact applied near center of convex section of test coupon. Coating shall show no signs of cracking or disbondment without magnification.
 - d. Manufacturer's Inspection and Certification:
 - 1) All coated fittings shall be visually inspected by manufacturer and show no sign of blisters, cracks, or lack of coverage.
 - 2) Check all coated fittings for coating thickness using magnetic film thickness gage utilizing method outlined in SSPC PA 2 Film Thickness Rating.
 - 3) Holiday-test all coated fittings in accordance with ASTM D5162, NACE RP0188, and SSPC Painting Manual Volume 1, Paragraph XIV, with low-voltage, wet sponge holiday detector. Repair methods and materials for holidays shall be as recommended by coating manufacturer and made prior to shipment to the Site.
 - e. Products and Manufacturers: Provide one of the following:
 - 1) PipeClad 1500, by Valspar Corporation.
 - 2) Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and

coatings.

- B. Visually inspect at the Site coated or lined pipe and fittings with ENGINEER and compare to approved Samples to verify lining continuity, surface gloss, and color, as applicable. Notify pipe manufacturer of damaged or unacceptable products. Pipe manufacturer shall visit the Site and perform testing to verify conformance with the Contract Documents to determine if products require replacement or repair. Repair or replace unacceptable products at no cost to OWNER.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

- A. For buried piping installation and testing, refer to Section 33 05 05, Buried Piping Installation.
- B. For exposed piping installation and testing, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 31

THERMOPLASTIC PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install thermoplastic piping and fittings.
2. Extent of piping is shown and shall be in accordance with piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before thermoplastic piping Work.

C. Related Sections:

1. Section 33 05 05, Buried Piping Installation.
2. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. AASHTO, Standard Specifications for Highway Bridges.
2. ASTM D1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
3. ASTM D1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
4. ASTM D2464, Specification for Threaded Poly (Vinyl Chlorinated) (PVC) Plastic Pipe Fittings, Schedule 80.
5. ASTM D2466, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
6. ASTM D2467, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
7. ASTM D2513, Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
8. ASTM D2564, Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
9. ASTM D2665, Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
10. ASTM D683, Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
11. ASTM D3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
12. ASTM D3035, Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
13. ASTM D3139, Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

14. ASTM D3212, Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
15. ASTM D3222, Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
16. ASTM D3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
17. ASTM D3311, Specification for Drain, Waste and Vent (DWV) Plastic Fittings Patterns.
18. ASTM D3350, Specification for Polyethylene Plastic Pipe and Fittings Materials.
19. ASTM D4101, Specification for Polypropylene Injection and Extrusion Materials.
20. ASTM F437, Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
21. ASTM F438, Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
22. ASTM F439, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
23. ASTM F441/F441M, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
24. ASTM F442/F442M, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
25. ASTM F477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
26. ASTM F656, Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
27. ASTM F679, Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
28. ASTM F714, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
29. ASTM F1055, Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
30. ASTM F1336, Specification for Poly (Vinyl Chloride) (PVC) Gasketed Sewer Fittings.
31. ASTM F1674, Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
32. ASTM F1760, Specification for Coextruded Poly (Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content.
33. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In.-12 In. (100 mm-300 mm), for Water Transmission and Distribution
34. AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
35. AWWA C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In.-48 In. (350 mm-1,200 mm).
36. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission.
37. AWWA C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In. (100 mm Through 300 mm).
38. NSF 14, Plastic Piping Systems Components and Related Material.
39. ANSI/NSF 61, Drinking Water System Components - Health Effects.
40. Standards of U.S. Food and Drug Administration.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Shall have a minimum of five years experience producing thermoplastic pipe and fittings substantively similar to the materials specified, and shall be able to submit documentation of satisfactory service in at least five completed installations in operation for at least five years each.
 - 2. Installer:
 - a. Engage a single pipe installer who shall be responsible for all thermoplastic pipe Work, and who shall employ only tradesmen with specific skills and experience in the type of Work required.
 - b. Installer shall have a minimum of five years experience installing thermoplastic pipe and fittings substantively similar to the materials specified and substantively similar to or larger than the scope of thermoplastic piping Work on the Project, and shall be able to submit documentation of satisfactory experience in at least five completed installations in operation for at least five years each.
- B. Component Supply and Compatibility:
 - 1. Obtain all materials included in this Section, regardless of component Supplier, from a single thermoplastic pipe Supplier. All pipe of each material type shall be furnished by the same manufacturer.
 - 2. Thermoplastic pipe Supplier shall review and approve to prepare all Shop Drawings and other submittals for all materials furnished under this Section.
 - 3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by thermoplastic pipe Supplier.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 2. Product Data:
 - a. Submit product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Submit manufacturer's certificate of compliance standards referenced in this Section.
 - 2. Source Quality Control Submittals:
 - a. When requested by ENGINEER, submit results of source quality control tests.
 - 3. Qualifications Statements:
 - a. Submit qualifications of manufacturer when requested by ENGINEER.
 - b. Submit qualifications of installer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS

- A. General:
 - 1. Pipe materials shall be suitable for services intended. Refer to piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 2. Pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, and other defects. Unless otherwise shown or indicated, pipe shall be uniform in color, opacity, density, and other physical properties.
 - 3. Comply with NSF 14.
 - 4. Buried pipe shall be capable of withstanding external live load, including impact, equal to AASHTO H-20 loading, with cover shown or indicated on the Drawings.

2.2 POLYVINYL CHLORIDE (PVC) PIPING

- A. PVC Pipe – General Applications: Unless otherwise shown or indicated, PVC pipe shall comply with the following:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Ipex, Inc.
 - b. Spears Manufacturing Company.
 - c. Or equal.
 - 2. Material: Unless otherwise specified, comply with the following:
 - a. Type and Grade: Type 1, Grade 1.
 - b. Wall Thickness: Exterior, underground, direct-buried conduit shall be schedule 80 and exterior, underground, concrete-encased conduit shall be schedule 40 complying with ASTM D1784 and ASTM D1785, and US Product Service PS 21-70 as having same outside diameter dimension as cast-iron pipe.
 - c. Temperature Rating: Rated for temperature to 140 degrees F.
 - d. Color: White or gray.
 - 3. Fittings: Type, grade, schedule, and color of fitting shall match the associated pipe.
 - a. Solvent Weld: Comply with ASTM D2466 for Schedule 40 and ASTM D2467 for Schedule 80.
 - b. Threaded: Threaded fittings shall comply with ASTM D2464.
 - c. Flanged: Provide flanged fittings with Neoprene gaskets.
 - 4. Joints:
 - a. Solvent Weld: Use primer and solvent cement recommended by PVC pipe manufacturer for the application. Primer shall be in accordance with ASTM F656, and solvent cement shall be in accordance with ASTM D2564.
 - b. Threaded: Use 100 percent virgin polytetrafluoroethylene (Teflon or PTFE) tape for threaded fittings. Pipe shall not be threaded.

- c. Flanged: Provide with backup flange minimum 1/8-inch thick. Backup flanges and connecting bolts shall be Type 304 stainless steel.
- B. Buried PVC Gravity Sewer Pipe.
 - 1. Manufacturers: Provide products of one of the following:
 - a. Ipex, Inc.
 - b. Diamond Plastics Corp.
 - c. Or equal.
 - 2. Material:
 - a. Pipe shall comply with ASTM D3034.
 - b. Wall Thickness and Pipe Stiffness: Pipe stiffness shall be determined in accordance with test methods in ASTM D3034.
 - 1) Main Line: SDR 35, with minimum ring stiffness of 46 psi.
 - 2) Service Laterals: SDR 28, with minimum ring stiffness of 90 psi.
 - 3. Fittings:
 - a. Injection-molded, gasketed fittings shall comply with ASTM F1336, and ASTM D3034.
 - b. Fabricated fittings shall comply with ASTM F1336.
 - c. Unless otherwise shown or indicated, saddle wyes are unacceptable.
 - 4. Joints:
 - a. Provide bell and spigot joints. Bell shall consist of an integral wall section to hold securely in place (and prevent displacement during assembly of joint) elastomeric O-ring gasket.
 - b. Jointing lubricant shall be as recommended by pipe manufacturer.
 - c. Provide elastomeric gaskets complying with ASTM F477, and ASTM D3139 or ASTM D3212.
- C. Buried PVC Pressure Pipe:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Ipex, Inc.
 - b. Diamond Plastics Corp.
 - c. Or equal.
 - 2. Material:
 - a. Pipe shall comply with AWWA C900 or AWWA C905 (as applicable).
 - b. Material shall comply with ASTM D1784.
 - c. Wall Thickness: SDR 18.
 - d. Fabricate pipe with cast-iron pipe equivalent outside diameter.
 - 3. Fittings:
 - a. Comply with AWWA C900, AWWA C905, or AWWA C907, as applicable.
 - 4. Joints:
 - a. Provide bell and spigot joints. Bell shall consist of an integral wall section to hold securely in place (and prevent displacement during assembly of joint) elastomeric O-ring gasket.
 - b. Jointing lubricant shall be as recommended by pipe manufacturer.
 - c. Provide elastomeric gaskets complying with ASTM F477 and ASTM D3139.
 - d. Restrained Joints: Provide restrained joints where shown or indicated.
 - 1) Comply with Section 33 05 05, Buried Piping Installation.
 - 2) Proprietary Joint Systems: Comply with ASTM F1674. Provide restrained joint system by one of the following for bell and spigot joint PVC piping:

- a) Ebaa Iron Sales, Inc.: Series 1500 and Series 1600 Restraint Harness for C900 Pipe; Megalug Series 2500, 2800, and 1100HV Restraint Harness for C905 Pipe.
 - b) PV-LOK Series, by Sigma Corp.
 - c) Or equal.
- D. PVC Drain, Waste, and Vent (PVC-DWV) Pipe.
 - 1. Manufacturers: Provide products of one of the following:
 - a. Chemtrol, manufactured by Nibco, Inc.
 - b. Spears Manufacturing Company.
 - c. Or equal.
 - 2. Material: In accordance with ASTM D1784. Unless otherwise shown or indicated, PVC-DWV pipe shall be:
 - a. Type and Grade: Type 1, Grade 1.
 - b. Wall Thickness: Schedule 40.
 - c. Color: White.
 - 3. Fittings: Manufactured in accordance with ASTM D2665 and ASTM D3311.
 - a. Solvent weld.
 - b. Spigot.
 - 4. Joints:
 - a. Solvent weld.
 - b. Threaded.

2.3 IDENTIFICATION

- A. Pipe material identification requirements are in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

2.4 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Pipe manufacturer shall maintain continuous quality control program.
 - 2. Where applicable and when requested by ENGINEER, submit results of source quality control tests specified in reference standards.
 - 3. CPVC plastic molding materials used for manufacturing pipe and fittings under this Section shall be tested for compliance with ASTM D1784.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

- A. For buried piping installation, refer to Section 33 05 05, Buried Piping Installation.
- B. For exposed piping installation, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 33

HIGH DENSITY POLYETHYLENE PROCESS PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, test, and place in satisfactory service the High Density Polyethylene (HDPE) process pipe and fittings as shown.
2. The extent of HDPE pipe and fittings to be furnished is shown and in the piping schedules included in Section 33 05 05, Buried Piping Installation.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the HDPE process pipe Work.

C. Related Sections:

1. Section 31 23 05, Excavation and Fill.
2. Section 09 91 00, Painting.
3. Section 33 05 05, Buried Piping Installation.
4. Section 40 05 53, Process Valves, 4-inch Diameter and Larger.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Society for Testing and Materials, Inc., (ASTM).
 - a. ASTM D 638, Test Method for Tensile Properties of Plastics.
 - b. ASTM D 696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics between - 30°C and 30°C with a Vitreous Silica Dilatometer.
 - c. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - d. ASTM D 790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - e. ASTM D 1238, Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
 - f. ASTM D 1248, Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
 - g. ASTM D 1505, Test Method for Density of Plastics by the Density-Gradient Technique.
 - h. ASTM D 1525, Test Method for Vicat Softening Temperature of Plastics.
 - i. ASTM D 1598, Test Method for Time-to-Failure of Plastic Pipe under Constant Internal Pressure.
 - j. ASTM D 1599, Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings.

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- k. ASTM D 1603, Test Method for Carbon Black in Olefin Plastics.
- l. ASTM D 1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
- m. ASTM D 2122, Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
- n. ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.
- o. ASTM D 2290, Test Method for Apparent Hoop Tensile Strength of Plastic Reinforced Plastic Pipe by Split Disk Method.
- p. ASTM D 2412, Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- q. ASTM D 2657, Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
- r. ASTM D 2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
- s. ASTM D 2837, Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- t. ASTM D 3035, Specification for Polyethylene (PE) Plastic Pipe (DR-PR), Based on Controlled Outside Diameter.
- u. ASTM D 3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- v. ASTM D 3350, Specification for Polyethylene Plastics Pipe and Fittings Materials.
- w. ASTM F 412, Terminology Relating to Plastic Piping Systems.
- x. ASTM F 714, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- y. ASTM F 1248, Test Method for Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.
- 2. American Water Works Association, (AWWA).
 - a. AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, 1/2-inch through 3-inch, for Water Service.
 - b. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution.
- 3. National Science Foundation, (NSF).
 - a. NSF 14, Plastics Piping Components and Related Materials.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturer shall have a minimum of five years experience producing substantial similar type materials and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
 - 2. HDPE process pipe and fittings shall be the product of a single manufacturer.
 - 3. The HDPE process pipe and fittings manufacturer shall have an established Quality Assurance Program responsible for inspecting incoming and outgoing materials.
 - 4. The HDPE process pipe and fittings manufacturer shall have an established Quality Assurance program responsible for assuring the long-term performance of materials and products.
 - 5. The HDPE process pipe and fitting manufacturer shall maintain permanent Quality Assurance/Quality Control (QA/QC) records.

- B. Installer's Qualifications:
 - 1. Engage a single installer regularly engaged in HDPE process piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
 - 2. Engage a single installer for the entire HDPE process piping system with undivided responsibility for performance and other requirements.
- C. Component Supply and Compatibility:
 - 1. The HDPE process pipe and fittings manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 2. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the HDPE process pipe and fittings manufacturer.

1.4 SUBMITTALS

- A. Submit these with Shop Drawings required under Section 33 05 05, Buried Piping Installation.
- B. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Details of piping system including location of supports, restraints, fittings, anchors, vents, low-point drains, termination assemblies and all accessories necessary for piping system.
 - b. Pipe laying schedules.
 - 2. Product Data:
 - a. Details of construction, fabrication, and pipe materials.
 - b. Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations.
 - 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Pipe testing procedures.
- C. Informational Submittals:
 - 1. Certificates:
 - a. Materials Certificates of Conformance: Submit certificates of conformance with Referenced Standards as required in Article 2.4, below.
 - b. Upon shipment, CONTRACTOR shall furnish the HDPE pipe manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the Project are in accordance with the requirements of this Section and a manufacturer's warranty covering materials and workmanship of the HDPE piping.
 - 2. Suppliers Instructions:
 - a. Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations.
 - 3. Qualifications Statements:
 - a. Installer's qualifications.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Refer to Sections 33 05 05, Buried Piping Installation.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. HDPE piping system shall be specifically designed, constructed, and installed for the service intended and shall comply with the following service conditions.
- B. Design Criteria:

Location:	HDD crossings
Nominal Pipe Size:	18"
Pipe Size Type:	DIPS
Average O.D. (in)	19.5
Dimension Ratio(DR)	11
Average I.D. (in)	15.741
Working Pressure Rating (psi)	200
Maximum Force Main Pressure	150
Joint Length (ft)	40/50
Flow (gpm)	1200
Fluid Composition	Wastewater

2.2 PHYSICAL PROPERTIES

- A. Materials used for the manufacture of polyethylene pipe and fittings shall meet the following physical property requirements:

Property	Unit	Test Procedure	Value
1. Material Designation	-	PPI/ASTM	-
2. PPI Material Listing	-	PPI TR-4	PE 3408
3. Material Classification	-	ASTM D 1248	III C 5 P34
4. Cell Classification	-	ASTM D 3350	345434C or 355434C
5. Density	g/cm3	ASTM D 1505	>0.941
6. Melt Index (E)	g/10 min	ASTM D 1238	<0.15
7. Flexural Modulus	psi	ASTM D 790	>110,000
8. Tensile Strength	psi	ASTM D 638	<160,000
9. ESCR (C)	hours	ASTM D 1693	3,000 to 3,500

Property	Unit	Test Procedure	Value
10. HDB	psi	ASTM D 2837	1,600 @ 23°C
11. UV Stabilizer (C) percent carbon black		ASTM D 1603	2 to 3
12. Elastic Modulus	psi	ASTM D 638	110,000
13. Brittleness Temperature F		ASTM D 746	<-180
14. Vicat Softening Temp F		ASTM D 1525	255
15. Thermal Expansion in/in/ F		ASTM D 696	8 x 10E-5
16. Hardness	Shore D	ASTM D 2240	64
17. Molecular Weight Category-		-	Extra-High

- B. There shall be no evidence of splitting, cracking or breaking when the pipe is tested in accordance with Article 2.4, below.
- C. Ring Stiffness Constant (RSC) values for the pipe can be directly related to the pipe's class designation. (Nominal RSC of Class 40 pipe = 40, etc.). The minimum RSC is 90 percent of the nominal.
- D. The HDPE pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.
- E. Clean rework or recycled material generated by the manufacturer's own production may be used as long as the pipe or fittings produced meet all the requirements of this Section.

2.3 PIPE AND FITTINGS

- A. Dimensions:
 - 1. Pipe Dimensions: The nominal inside diameter of the pipe shall be true to the specified pipe size in accordance with AWWA C901 and AWWA C906. Standard laying lengths shall be 50 feet ± 2-inches.
 - 2. Fitting Dimensions: Fittings such as couplings, wyes, tees, adapters, etc. for use in laying pipe shall have standard dimensions that conform to ASTM D 3261.
- B. Pipe and fittings shall be produced from identical materials, meeting the requirements of this Section, by the same manufacturer. Special or custom fittings may be exempted from this requirement.
- C. Pipe and fittings shall be pressure rated to meet the service pressure requirements specified by ENGINEER. Whether molded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.
- D. Molded fittings shall meet the requirements of ASTM D 3261 and this Section. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the diameter and wall thickness specifications of the mating system pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. The manufacturer shall provide an explanation of the production codes used.

- E. Reducing tees with branch diameters of 16-inches or less shall be saddle tees.
- F. Marking:
 - 1. Each standard and random length of pipe and fitting in compliance with this standard shall be clearly marked with the following information.
 - a. ASTM or AWWA Standard Designation.
 - b. Pipe Size.
 - c. Class and Profile Number.
 - d. Production Code.
 - e. Standard Dimension Ratio (SDR).

2.4 SOURCE QUALITY CONTROL

- A. At a minimum, incoming polyethylene materials shall be inspected for density in accordance with ASTM D 1505 and melt flow rate in accordance with ASTM D 1238. All incoming polyethylene materials shall be certified by the supplier. Certification shall be verified by CONTRACTOR and ENGINEER. Incoming materials shall be approved by Manufacturer's Quality Assurance Program before processing into finished goods.
- B. Representative samples of polyethylene materials shall be tested against the physical property requirements required herein. Each extrusion line and molding machine shall be qualified to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D 1598.
- C. Quality Assurance test for representative pipe and fitting samples shall include:

<u>Test</u>	<u>Standard</u>	<u>Pipe</u>	<u>Fittings</u>
Ring ESCR	ASTM F 1248	Yes	Not Applicable
Sustained pressure at 176°F/725 psi hoop stress: (f ₀ >100 h)	ASTM D 1598	Yes	Yes
Sustained pressure at 73°F/1,600 psi hoop stress: (f ₀ >1000 h)	ASTM D 1598	Yes	Yes

- D. The HDPE pipe and fitting manufacturer shall certify that samples of their production pipe have undergone stress regression testing, evaluation, and validation in accordance with ASTM D 2837 and PPI TR-3. Under these procedures, the minimum hydrostatic design basis shall be certified by the pipe and fitting manufacturer to be 1,600 psi at 73.4°F and 800 psi at 140°F.
- E. Material shall be listed in the name of the HDPE pipe and fitting manufacturer as required by the Plastics Pipe Institute (PPI) in PPI TR-4 with the following Standard Grade ratings:

	<u>73.4°F</u>	<u>140°F</u>
1. Hydrostatic Design Basis (HDB)	1,600 psi	800 psi
2. Hydrostatic Design Stress (HDS)	800 psi	400 psi

PPI material listing in the name of the resin supplier is not acceptable in meeting this requirement.

F. Inspection Requirements:

1. Notification: The HDPE pipe and fitting manufacturer shall notify CONTRACTOR in advance of the date, time, and place of testing of the pipe in order that CONTRACTOR may be represented at the test.
2. Access: The OWNER'S representative shall have free access to the Inspection area of the manufacturer's plant. The manufacturer shall make available to the OWNER'S representative, without charge, all reasonable facilities for determining whether the pipe meets the requirements of this Section.
3. Certification: As the basis of the acceptance of the material, the manufacturer will furnish a certificate of conformance of these Specifications upon request. When prior agreement is being made in writing between ENGINEER, CONTRACTOR and the manufacturer, the manufacturer will furnish other conformance certification in the form of affidavit of conformance, test results, or copies of test reports.
4. All outgoing materials shall be inspected for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. Manufacturer's Quality Control Program shall perform tests of density, melt flow rate, carbon content, and carbon dispersion. In addition, samples of the pipe provided shall be tested for hoop tensile strength and ductility by either quick burst in accordance with ASTM D 1599 or ring tensile strength in accordance with ASTM D 2290. Molded fittings shall be subject to x-ray inspection for voids, and tests for knit line strength. All fabricated fittings shall be inspected for fusion quality and alignment.

G. Physical Test Requirements:

1. Sampling: The selection of the sample of pipe shall be as agreed upon by the ENGINEER, CONTRACTOR and the manufacturer. In case of no prior agreement, any sample selected by the manufacturer shall be deemed adequate.
2. Sample size for flattening test will be one sample for each size and class of pipe for the Project.
3. Conditioning: Conditioning of samples prior to and during test shall be as agreed upon by the ENGINEER, CONTRACTOR and manufacturer. In case of no prior agreement, the conditioning procedure used by the manufacturer shall be deemed adequate.

H. Test Methods:

1. Flattening: Three specimens of pipe, a minimum of 12-inches long, shall be flattened between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes. Remove the load, and examine the specimens for splitting cracking or breaking.
2. Pipe Ring Stiffness Constant: The pipe ring stiffness constant shall be determined utilizing procedures similar to those outlined in ASTM D 2412. The stiffness of HDPE pipe is defined in terms of the load, applied between parallel plates, which causes one percent reduction of pipe

diameter. Test specimens shall be a minimum of two pipe diameters or four feet in length, whichever is less.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Pipe may be rejected for failure to conform to these Specifications or following:
 - 1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2-inches in length at either end of pipe which could be cut off and discarded. Pipes within one shipment shall be rejected if defects exist in more than five percent of shipment or delivery.
 - 2. Cracks sufficient to impair strength, durability or serviceability of pipe.
 - 3. Defects indicating improper proportioning, mixing, and molding.
 - 4. Damaged ends, where such damage prevents making satisfactory joint.
 - 5. Gouges or scrapes exceeding ten percent of the specified wall thickness.
- B. Acceptance of fittings, stubs or other specifically fabricated pipe sections shall be based on visual inspection at Site and documentation of conformance to these Specifications.
- C. CONTRACTOR to provide as-built of pipe end point and angle point coordinates and elevations prior to backfilling trench.

3.2 INSTALLATION

- A. Refer to Section 33 05 05, Buried Piping Installation.
- B. Heat Fusion of Pipe:
 - 1. HDPE pipe and fittings joints shall be heat fused by a qualified technician; trained by the manufacturer's representative in accordance with the manufacturer's recommended fusion procedures. Training must have occurred within the previous 12 months, or submittals verifying experience within the previous 12 months for all technicians performing heat fusion on polyethylene pipe and fittings.
 - 2. Weld in accordance with manufacturer's recommendation for butt fusion methods. Personnel operating fusion equipment shall be certified by the HDPE pipe manufacturer.
 - 3. The first butt fusion weld of each day's production welding and for each separate operator shall be tested by bent strap test method. No production welds shall be performed until successful completion of bent strap test.
 - 4. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by HDPE pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures. The equipment used for the heat fusion joints shall be capable of recording the heating and fusion pressures used to join the HDPE pipe, recording heater temperature, and storing this information for future retrieval (data logger). Each field fusion shall be recorded by such equipment and this information shall be made compiled into daily log reports. Log reports shall be submitted to CONTRACTOR and ENGINEER daily. Reports shall also include the results of the bent strap tests.

5. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.
6. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade. Shop Drawings shall address locations and deflections of required fittings to prevent installation that exceeds a greater degree of bending than the manufacturer's recommended minimum bending radius for each size and class of HDPE pipe.
7. Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
8. Branch saddle fusions shall be joined in accordance with manufacturer's recommendations and procedures. Branch saddle fusion equipment shall be of size to facilitate saddle fusion within trench.
9. Before butt fusing pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris from pipe.
10. Cover open ends of fused pipe at the end of each day's Work. Cap to prevent entry by animals or debris.

C. Flange Jointing:

1. Use on flanged pipe connection sections.
2. Connect slip-on Type 316 stainless steel backup flanges with Type 316 stainless steel nuts and bolts.
3. Butt fuse fabricated flange adapters to pipe.
4. Observe following precautions in connection of flange joints.
 - a. Align flanges or flange/valve connections to provide tight seal. Require nitrile-butadiene gaskets if needed to achieve seal. Integral flange adapters and gaskets are required for flange/valve connections.
 - b. Place U.S. Standard round washers as may be required on some flanges in accordance with manufacturer's recommendations. Bolts shall be lubricated in accordance with manufacturer's recommendations.
 - c. Tighten flange bolts in sequence and accordance with manufacturer's recommendations. CAUTION: Do not over-torque bolts.
5. Pull bolt down by degrees to uniform torque in accordance with manufacturer's recommendation.
6. Install electrofusion couplers, where used, in accordance with manufacturer's specifications.

D. Pipe Placement:

1. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Dewatering: Remove standing water in trench before pipe installation.
3. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion, but shall not exceed 400 feet.
5. Cap pipe sections longer than single joining (usually 50 feet) on both ends during placement, except during fusing operations.

6. Notify ENGINEER prior to installing pipe into trench and allow time for ENGINEER'S inspection.
 - a. Correct irregularities found during inspection.
 7. Complete tie-ins within trench whenever possible to prevent overstressed connections.
 8. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins or backfilling activity.
 9. Install reducers adjacent to laterals and tees.
 10. To reduce branch saddle stress, install saddles at slope equal to and continuous with lateral piping.
 11. Pipe shall be snaked in trench to allow a minimum of 12-inches/100 feet for thermal contraction and expansion.
 12. Allow extra length at future connection points to be cut to fit after backfill and prior to tie-in.
- E. Saddle tees 8-inches and smaller may be field fabricated. Field fabrication may only be performed by persons trained and certified by the manufacturer. Submit certification of qualified persons before fabricating any saddle tees. Saddle tees larger than 8-inches must be factory manufactured.

3.3 LEAKAGE TESTS

- A. Refer to Section 33 05 05, Buried Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 53

PROCESS VALVES, FOUR-INCH DIAMETER AND LARGER

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install process valves, four-inch diameter and larger, and appurtenances, complete and operational.
 - 2. Valves for digester gas and air have been specifically identified. All other valves are for liquid service.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before process valves Work.
- C. Related Sections:
 - 1. Section 05 05 33, Anchor Systems.
 - 2. Section 09 91 00, Painting.
 - 3. Section 33 05 05, Buried Piping Installation.
 - 4. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American Bearing Manufacturers Association (ABMA).
 - 2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
 - 3. ANSI B16.34, Valves-Flanged, Threaded and Welding end. (ASME B16.34).
 - 4. ANSI/NSF 61 Drinking Water Components – Health Effects.
 - 5. API STD 594, Check Valves, Flanged Lug, Wafer and Butt-Welding.
 - 6. API STD 598, Valve Inspection and Testing.
 - 7. API STD 609, Butterfly Valves: Double Flanged, Lug-Type and Wafer-Type.
 - 8. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - 9. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - 10. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.
 - 11. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 12. ASTM A276, Specification for Stainless Steel Bars and Shapes.
 - 13. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

14. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
15. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
16. ASTM A536, Specification for Ductile Iron Castings.
17. ASTM A564/A564M, Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
18. ASTM A743/A743 M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
19. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
20. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
21. ASTM B138/B138M, Specification for Manganese Bronze Rod, Bar and Shapes.
22. ASTM B265, Specification for Titanium and Titanium Alloy Strip, Sheet and Plate.
23. ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
24. ASTM D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
25. AWWA C500, Metal-Seated Gate Valves for Water Supply Service.
26. AWWA C501, Cast-Iron Sluice Gates.
27. AWWA C502, Dry-Barrel Fire Hydrants.
28. AWWA C504, Rubber-Seated Butterfly Valves.
29. AWWA C507, Ball Valves, 6-inch through 48-inch.
30. AWWA C508, Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
31. AWWA C509, Resilient-Seated Gate Valves for Water Supply Service.
32. AWWA C540, Power-Actuating Devices for Valve and Slide Gates.
33. AWWA C550, Protective Interior Coatings for Valves and Hydrants.
34. AWWA Manual M49, Butterfly Valves: Torque, Head Loss, and Cavitation Analysis.
35. FS TT-C-494, Coating Compound, Bituminous, Solvent Type, Acid-Resistant.
36. NEMA MG 1, Motors and Generators.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to provide evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer of the type of process valve. For each type of valve, do not furnish valves of more than one manufacturer.
 2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of process valve Supplier is furnishing.

3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the process valve manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Installation drawings showing orientation of valve in both plan and elevation view. Drawings shall clearly identify valve and its appurtenances, including controls, actuators, valve stems, and other components. Show dimensions of valves and appurtenances in relation to piping and structural and architectural components, where applicable.
 - b. Controls for and control characteristics of modulating valves.
 - c. Power and control wiring diagrams, including terminals numbers for electric-motor actuators.
 - d. Calculations for sizing of electric actuators.
 - e. Calculations for sizing of operating mechanism with extension stems.
 - f. Calculations for sizing of gear actuators.
2. Product Data:
 - a. Product data sheets.
 - b. Complete catalog information, including dimensions, weight, specifications, and identification of materials of construction of all parts.
 - c. Corrosion resistance information to confirm suitability of valve materials for the application. Furnish information on chemical resistance of elastomers from elastomer manufacturer.
 - d. Cv values and hydraulic headloss curves.
3. Testing Plans:
 - a. Submit plan for shop testing of each valve for which shop testing is specified, including testing plan's and test facility's limitations proposed.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by ENGINEER.
2. Manufacturer Instructions:
 - a. Submit manufacturer's instructions for handling, storing, and installing valves and appurtenances. Provide templates and setting drawings for valves and appurtenances that require anchor bolts or similar anchorages.
3. Source Quality Control Submittals:
 - a. Submit copies of shop test results and inspection data, certified by manufacturer.
4. Field Quality Control Submittals:
 - a. Submit results of field tests required.
5. Supplier's Reports:

- a. When requested by ENGINEER, submit written report of results of each visit to Site by Supplier's serviceman, including purpose and time of visit, tasks performed and results obtained.
- 6. Qualifications Statements:
 - a. When requested by ENGINEER, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.
- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:
 - a. Furnish operation and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
 - b. Furnish in operations and maintenance manuals complete nameplate data for each valve and electric actuator.
- D. Maintenance Material Submittals: Submit the following:
 - 1. Spare Parts, Extra Stock Materials, and Tools:
 - a. Spare Parts and Extra Stock Materials: Furnish as specified for each valve type.
 - b. Tools: Furnish two sets of special tools (excluding metric tools, if applicable) for each size and type of valve furnished.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
 - 2. Inspect boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
 - 3. Conform to Section 01 65 00, Product Delivery Requirements.
- B. Storage and Protection:
 - 1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by extreme temperatures. Store in accordance with manufacturer's recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.
 - 2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Valves, General:
 - 1. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.

2. Provide valves with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
 - a. Valve size.
 - b. Pressure and temperature ratings.
 - c. Application (other than water and wastewater).
 - d. Date of manufacture.
 - e. Manufacturer's name.
 3. Provide valves to turn clockwise to close, unless otherwise specified.
 4. Provide valves with permanent markings for direction to open.
 5. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.
- B. Valve Materials:
1. Valve materials shall be suitable for the associated valve's service or application, as shown.
 2. Protect wetted parts from galvanic corrosion caused by contact of different metals.
 3. Wetted components and wetted surfaces of valves used with potable water or water that will be treated to become potable shall conform to ANSI/NSF 61.
 4. Clean and descale fabricated stainless steel items in accordance with ASTM A380 and the following:
 - a. Passivate all stainless steel welded fabricated items after manufacture by immersing in pickling solution of six percent nitric acid and three percent hydrofluoric acid. Temperature and detention time shall be sufficient for removing oxidation and ferrous contamination without etching surface. Perform complete neutralizing operation by immersing in trisodium phosphate rinse followed by clean water wash.
 - b. Scrub welds with same pickling solution or pickling paste and clean with stainless steel wire brushes or by grinding with non-metallic abrasive tools to remove weld discoloration, and then neutralize and wash clean.
- C. Valve Joints:
1. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
 2. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.
 3. For stainless steel bolting, except where nitrided nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

2.2 METAL-SEATED GATE VALVES – SOLID WEDGE AND DOUBLE DISC TYPE

- A. Manufacturers: Provide products of one of the following:

Home Depot MPS and FM
Process Valves Four-inch Diameter and Larger
30036073 40 05 53-5

1. M&H Valve Company.
 2. US Pipe and Foundry.
 3. Or equal.
- B. General:
1. Provide valves conforming to AWWA C500 and as specified in this Section.
 2. Sizes:
 - a. Non-Rising-Stem (NRS): Four-inch through 48-inch diameter.
 - b. Outside Screw and Yoke (OS&Y) Rising-Stem: Four-inch through 12-inch diameter.
 3. Type:
 - a. Provide NRS valves for buried service.
 - b. Provide OS&Y rising-stem valves for exposed service unless specified otherwise.
 - c. Provide position indicators for NRS valves used for exposed service.
 4. Minimum Rated Working Pressure:
 - a. Valves 12-inch Diameter and Smaller: 200 psig.
 - b. Valves 16-inch Diameter and Larger: 150 psig.
 5. Maximum Fluid Temperature: 150 degrees F.
 6. Provide tongue-and-groove guides for solid-wedge valves.
 7. Provide rollers and tracks for horizontal 16-inch diameter and larger double disc valves.
 8. Provide double disc valves with minimum four-point wedging mechanism.
 9. Unless otherwise specified, provide bypass for valves 16-inch diameter and larger. Bypasses shall be bolted construction and bypass valves shall be similar to the associated main valve. Minimum size of bypass valves shall be as specified in AWWA C500.
- C. Materials of Construction: Materials of construction shall conform to AWWA C500 and shall be as follows:
1. Valve Body, Bonnet, Stuffing Box, and Discs: Gray iron or ductile iron.
 2. Seat and Disc Rings: Bronze.
 3. Stem and Stem Nut: Bronze.
 4. Disc Pin and Side Spreader: Bronze.
 5. Top and Bottom Wedge Nuts: Cast-iron with integrally cast bronze bushing.
 6. Guide Contacts for 16-inch Diameter and Larger Valves: Bronze.
 7. Rollers and Tracks: Bronze.
 8. Internal and external bolting and other hardware, including pins, set screws, studs, bolts, nuts, and washers, shall be Type 316 stainless steel.
 9. Rubber Items: Buna-N or other synthetic rubber suitable for application.
- D. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.
- E. Testing:
1. Test valves in valve manufacturer's shop in conformance with AWWA C500.

- F. Gear Actuators for Manually-operated Valves:
 - 1. Provide gear actuators for valves, in accordance with AWWA C500.
 - 2. Size gear actuators per the final project plans.

2.3 RESILIENT-SEATED GATE VALVES

- A. Manufacturers: Provide products of one of the following:
 - 1. M&H Valve Company
 - 2. US Pipe and Foundry.
 - 3. Or equal.
- B. General:
 - 1. Provide valves conforming to AWWA C509 and as specified in this Section.
 - 2. Sizes: Four-inch through 12-inch diameter, 16-inch and 20-inch diameter.
 - 3. Type:
 - a. Provide non-rising stem (NRS) valves for buried service.
 - b. For interior and exposed service, provide outside screw and yoke (OS&Y) rising-stem valves, unless otherwise specified.
 - c. Provide position indicators for NRS valves used in exposed service.
 - 4. Minimum Rated Working Pressure:
 - a. Valves 12-inch Diameter and Smaller: 200 psig.
 - b. Valves 16-inch and 20-inch Diameter: 150 psig.
 - 5. Maximum Fluid Temperature: 150 degrees F.
 - 6. Provide valves with fully encapsulated resilient wedges, unless otherwise specified.
- C. Materials of Construction: Shall conform to AWWA C509 and shall be as follows:
 - 1. Valve Body, Bonnet, and Stuffing Box: Cast-iron.
 - 2. Wedge: Cast-iron, symmetrically and fully encapsulated with molded rubber having minimum 1/8-inch thickness.
 - 3. Stem: Manganese bronze.
 - 4. Rubber Items: Buna-N or other synthetic rubber suitable for the application.
 - 5. Internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
- D. Interior Coating:
 - 1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.
- E. Testing:
 - 1. Test valves in valve manufacturer's shop in accordance with AWWA C509.
- F. Gear Actuators for Manually-operated Valves:
 - 1. Provide valves with gear actuators conforming to AWWA C500.
 - 2. Size gear actuators for the maximum differential pressures specified in the final project plans.

2.4 ECCENTRIC PLUG VALVES

- A. Manufacturers: Provide products of one of the following:
 - 1. DeZurik.
 - 2. Or equal.
- B. General:
 - 1. Provide eccentric-type plug valves each with rectangular ports.
 - 2. Minimum Rated Working Pressure:
 - a. Valves 12-inch Diameter and Smaller: 175 psig.
 - b. Valves 14-inch through 72-inch Diameter: 150 psig.
 - 3. Maximum Fluid Temperature: 180 degrees F.
 - 4. Minimum Port Area:
 - a. Valves 20-inch Diameter and Smaller: 80 percent of nominal pipe area.
 - b. Valves Larger than 20-inch Diameter: 70 percent of nominal pipe area.
 - 5. Packing and packing gland shall be externally adjustable and accessible without disassembling valve and without removing the actuator.
 - 6. Valves shall provide drip-tight, bi-directional shutoff at rated pressures.
 - 7. Plug shall have cylindrical seating surface eccentrically offset from center of plug shaft. Interface between plug face and body seat, with plug in closed position, shall be externally adjustable in the field with valve in the line while under pressure.
 - 8. Plug shall be supported to top bearing by using spring that is externally adjustable.
 - 9. For sludge service, plug valves shall allow pigging of the piping with line-size pigs.
- C. Materials of Construction:
 - 1. Body: Cast Iron ASTM A126 Class B, or Ductile-iron ASTM A536 Grade 65-45-12.
 - 2. Plug:
 - a. Core: Cast Iron ASTM A126 Class B, or Ductile-iron, ASTM A536 Grade 65-45-12.
 - b. Plug Facing: Neoprene.
 - c. For valves up to eight-inch diameter, plugs shall be fully encapsulated with rubber. For valves larger than eight-inch diameter, provide plugs with rubber facing. Minimum thickness of rubber lining shall be 1/8-inch. Rubber hardness shall be a minimum of 70 (Shore A) durometer. Rubber-to-metal bond shall withstand minimum 75-pound pull conforming to ASTM D429 Method B.
 - 3. Seats: Minimum 1/8-inch welded overlay of minimum 90 percent pure nickel on surfaces contacting plug face. Seats shall provide contact area of at least 1/2-inch width all around.
 - 4. Stem Bearings: Sintered, oil impregnated, permanently lubricated of Type 316 stainless steel.
 - 5. Stem Seal: Multiple neoprene V-ring type.
 - 6. All internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts and washers shall be Type 316 stainless steel.
- D. Interior Coating and Lining:

1. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.
- E. Shop Testing:
1. Operational Tests:
 - a. To demonstrate that complete assembly is workable, successfully operate each valve (with actuator mounted directly on valve) three times from fully closed to fully open position and reverse under no-flow condition.
 2. Leakage Tests:
 - a. Test each valve for leaks while valve is in closed position.
 - b. Test valves at rated pressures. During test, valves shall be drip-tight. Test duration shall be at least five minutes for valves up to 20-inch diameter and ten minutes for valves larger than 20-inch diameter. Tests shall be repeated successfully with pressure in the unseating direction.
 3. Hydrostatic Test: Test valves to an internal hydrostatic pressure equivalent to twice rated pressure of valve. During hydrostatic test, there shall be no leakage through metal, end joints, and shaft seal, nor shall any part be permanently deformed. Duration of hydrostatic test shall be sufficient to allow visual examination for leakage. Test duration shall be at least one minute for valves eight-inch diameter and smaller, three minutes for valves 10-inch through 20-inch diameter, and ten minutes for valves 24-inch diameter and larger.
- F. Gear Actuators for Manually-operated Valves:
1. Provide gear actuators on buried and exposed valves, except valves four-inch diameter and smaller located less than five feet above operating floor. Gas service valves shall be provided with worm gear actuators.
 2. Size gear actuators for valves eight-inch diameter and smaller for 175 psig differential pressure.
 3. Size gear actuators for valves larger than eight-inch diameter for the maximum differential pressures per the final project plans.
 4. Provide actuators capable of holding associated valves in any intermediate position without creeping or vibrating.
 5. Provide valve position indicator on each actuator. Provide stop-limiting devices for open and closed position. For buried and submerged service actuators, provide position indicators in valve box.
 6. Provide adjustable stop to adjust seating pressure.
 7. Make packing accessible for adjustment without requiring removal of actuator from valve, except for valves in buried and submerged service.
 8. Diameter ratio of handwheel or chainwheel and gear sector shall be less than two.
 9. For buried and submerged valves, gear actuator shall be grease-packed and designed to withstand submersion, and shall be drip-tight in water 20 feet deep, with self-adjusting packing.
 10. Provide each actuator with gearing totally enclosed.
 11. Operator shaft and gear sector shall be supported on permanently lubricated bronze or stainless steel bearings.
 12. Provide metal-encased spring loaded seals in top and bottom covers of gear housing.

13. Actuators shall be provided to produce indicated torque with maximum pull of 40 pounds on handwheel or chainwheel and maximum input of 150-foot pounds on operating nuts, for both seating and unseating heads equal to maximum differential pressure rating of valve.
14. Actuator components between input and stops shall be designed to withstand, without damage, a pull of 200 pounds for handwheel or chainwheel actuators and input torque of 300-foot pound for operating nuts when operating against stops.
15. Materials of Construction:
 - a. Housing: Cast-iron, ASTM A126 Class B.
 - b. Gear Sector: Cast-iron ASTM A126 Class B, or ductile iron ASTM A536.
 - c. Worm Shaft: Steel, AISI 1144, hardened and tempered to an average Rc 40 and within range of Rc 35-45.
 - d. Bearings: Bronze oil-impregnated, or stainless steel.
 - e. Hardware, including bolts, nuts, washers, set screws, and pins, shall be Type 316 stainless steel.

2.5 RUBBER SEATED BALL VALVES

- A. Manufacturers: Provide products of one of the following:
 1. APCO Willamette Valve & Primer Corporation.
 2. Henry Pratt Company.
 3. Or equal.
- B. General:
 1. Provide valves conforming to AWWA C507 and as specified herein.
 2. Sizes: Six-inch through 48-inch diameter.
 3. Rated Working Pressure: 150 psig.
 4. Maximum Fluid Temperature: 180 degrees F.
 5. Valve body shall have full, unobstructed, circular inlet and outlet port diameters equal to nominal diameter of valve.
 6. Valves shall provide drip-tight bi-directional shutoff at rated pressures.
 7. Valve bodies shall have support legs or pads to support the valve and actuator weight when installed in horizontal pipeline.
 8. Support ball assembly by two-way thrust bearing assembly consisting of stud and thrust collar in grease-packed cavity suitable for lifetime lubrication.
 9. Valve seats shall seal full 360-degree circumference without interruption.
 10. Valve seats shall be field-adjustable around 360-degree circumference and replaceable without dismantling operator, shaft, or ball.
 11. Packing shall be self-adjusting, chevron type and shall be accessible without having to dismantle valve.
- C. Materials of Construction: Materials of construction shall conform to AWWA C507 and as follows:
 1. Body: Gray iron, ductile iron, or cast steel.
 2. Ball: Gray iron, ductile iron, or cast steel.
 3. Rubber Seats in Body, Bearing Seal O-Rings: Buna-N or other synthetic rubber suitable for the application.
 4. Seating Surface on Ball: Type 316 stainless steel or nickel-chrome.
 5. Shaft: Type 316 stainless steel.

6. Tapered Pins for Attachment of Shaft to Ball: Type 316 stainless steel.
 7. Bearings: Teflon-lined with fiberglass backing, self-lubricating.
 8. Thrust Collar and Stud Bolt of Thrust Bearing Assembly: Type 316 stainless steel.
 9. Shaft Seals: Self-adjusting V-type chevron packing.
 10. Internal and external bolting and other hardware, including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
- D. Testing:
1. Test each valve in manufacturer's shop in accordance with AWWA C507.
- E. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.
- F. Gear Actuator for Manual Valves:
1. Provide valves with gear actuators conforming to AWWA C507.
 2. Size gear actuators for valves 10-inch diameter and smaller for differential pressure equal to rated pressure of valve and port velocity of 35 feet per second.
 3. Gear actuators for valves larger than 10-inch diameter shall be sized for maximum differential pressures and flow velocities as specified in the final project plans.

2.6 SWING CHECK VALVES

- A. Manufacturers: Provide products of one of the following:
1. APCO Willamette Valve & Primer Corp.
 2. Crispin Valve
 3. G.A. Industries.
- B. General:
1. Provide valves conforming to AWWA C508 and as specified herein.
 2. Sizes: Four-inch through 24-inch diameter.
 3. Type: Resilient-seated.
 4. Rated Working Pressure:
 - a. Smaller than 12-inch Diameter: 175 psig.
 - b. 12-inch Diameter and Larger: 150 psig.
 5. Provide valves suitable for horizontal or vertical mounting.
 6. Check valves shall have clear waterway with full-open area equal to nominal pipe size.
 7. Provide check valves with outside adjustable weight and lever.
 8. Provide valves larger than six-inch diameter with adjustable air cushion chambers.
 9. Valve seats shall be mechanically attached and shall be field replaceable.
- C. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:
1. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
 2. Disc Arm: Ductile iron.
 3. Hinge Shaft: Type 316 stainless steel.

4. Hinge Shaft Bushings: Bronze, or Type 316 stainless steel for sewage service.
 5. Shaft End Plate: Type 316 stainless steel.
 6. Body Seat: Type 316 stainless steel.
 7. Follower Ring for Rubber Seat on Disc: Type 316 stainless steel.
 8. Disc Center Pin Assembly: Type 316 stainless steel.
 9. Air Cushion Chamber:
 - a. Chamber and Plunger: Bronze.
 - b. Linkages and Pins: Type 316 stainless steel.
 - c. Air Check Valve and Tubing: Brass or stainless steel.
 10. Rubber Items:
 - a. Applications Up to 180-degree F Fluid Temperature: Buna-N or other synthetic rubber suitable for the application.
 - b. Applications 180-degrees F and Greater Fluid Temperature: Viton, or other synthetic rubber suitable for the application.
 11. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
 12. Gland Packing: Graphite and Kevlar.
- D. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.
- E. Testing:
1. Test each valve in manufacturer's shop in accordance with AWWA C508.
 2. Allowable Leakage at Rated Pressures: Zero.

2.7 APPURTENANCES FOR EXPOSED METALLIC VALVES

- A. General:
1. For valves located less than five feet above operating floor, provide levers on four-inch diameter quarter-turn valves, and provide handwheels on all other valves, unless otherwise shown or specified.
 2. For valves located five feet or more above operating floor, provide chain operators.
 3. Where indicated, provide extension stems and floorstands.
- B. Handwheels:
1. Conform to applicable AWWA standards.
 2. Material of Construction: Ductile iron, or cast aluminum.
 3. Arrow indicating direction of opening and word "OPEN" shall be cast on trim of handwheel.
 4. Maximum Handwheel Diameter: 2.5 feet.
- C. Chain Operators:
1. Chains shall extend to three feet above operating floor.
 2. Provide 1/2-inch stainless steel hook bolt to keep chain out of walking area.
 3. Materials of Construction:
 - a. Chain: Type 316L stainless steel.

- b. Chainwheel: Recessed groove type made out of Type 316 stainless steel.
 - c. Guards and Guides: Type 316L stainless steel.
 - 4. Chain Construction:
 - a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends is unacceptable.
 - 5. Provide geared operators where required to position chainwheels in vertical position.
- D. Crank Operator:
 - 1. Crank operator shall be removable and fitted with rotating handle.
 - 2. Maximum Radius of Crank: 15 inches.
 - 3. Materials:
 - a. Crank: Cast-iron or ductile iron.
 - b. Handle: Type 304 stainless steel.
 - c. Hardware: Type 304 stainless steel.
- E. Extension Stems and Floor Stands for Gate Valves:
 - 1. Conform to the applicable requirements of AWWA C501 for sizing of complete lifting mechanism.
 - 2. Bench and Pedestal Floor Stands:
 - a. For valves requiring extension stems, provide bench or pedestal floor stands with handwheel or crank as indicated. Provide provisions for using portable electric actuator for opening and closing of valves.
 - b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering housing. Provide lubrication fitting for grease. For valves conveying water that is potable or that will be treated to become potable, grease shall be food-grade and ANSI/NSF 61-listed. Base shall be machined.
 - c. Materials of Construction:
 - 1) Housing: Cast-iron, ASTM A126, Class B.
 - 2) Lift Nut: Cast bronze, ASTM B98/B98M.
 - 3) Grease Fitting: Stainless steel.
 - 4) Bolting: Type 316 stainless steel.
 - 3. Wall brackets for floor stands shall be Type 316L stainless steel construction.
 - 4. Extension Stems:
 - a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
 - b. Maximum Slenderness Ratio (L/R): 100.
 - c. Minimum Diameter: 1.5-inch.
 - d. Threads: Acme.
 - e. Provide stem couplings where stems are furnished in more than one piece. Couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
 - f. Weld to bottom of extension stem a Type 316 stainless steel cap suitable for square end of valve stem.
 - 5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
 - 6. Stem Guides:

- a. Material: Type 316 cast stainless steel with bronze bushing for stem. For submerged service, Type 316 cast stainless steel with stainless steel bushing for stem.
 - b. Maximum Stem Length Between Guides: Seven feet.
 - c. Stem guides shall be adjustable in two directions.
 - 7. Furnish stem cover of clear butyrate plastic or Grade 153 Lexan with cast adapter for mounting cover to bench and floor stands. Provide stem cover with gasketing and breathers to eliminate water intrusion into operator and condensation within cover. Provide stem cover with mylar tape with legible markings showing valve position at one-inch intervals and open and close limits of valve.
- F. Floor Boxes: Provide cast-iron floor boxes for valves that are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.8 APPURTENANCES FOR BURIED METALLIC VALVES

- A. Wrench Nuts:
- 1. Provide wrench nuts on buried valves of nominal two-inch size, in accordance with AWWA C500.
 - 2. Arrow indicating direction of opening the valve shall be cast on the nut along with the word "OPEN".
 - 3. Material: Ductile iron or cast-iron.
 - 4. Secure nut to stem by mechanical means.
- B. Extension Stems for Non-Rising Stem Gate Valves and Quarter-turn Buried Valves:
- 1. Provide extension stems to bring operating nut to six inches below valve box cover.
 - 2. Materials of Stems and Stem Couplings: Type 316 stainless steel.
 - 3. Maximum Slenderness Ratio (L/R): 100
 - 4. Provide top nut and bottom coupling of ductile iron or cast-iron with pins and set screws of Type 316 stainless steel.
- C. Valve Boxes:
- 1. Valve boxes shall be as indicated and as required.
 - 2. Type: Heavy-duty, suitable for highway loading, two-piece telescopic, and adjustable. Lower section shall enclose valve operating nut and stuffing box and rest on valve bonnet.
 - 3. Material: Cast-iron or ductile iron.
 - 4. Coating: Two coats of asphalt varnish conforming to FS TT-C-494.
 - 5. Marking: As required for service.

2.9 ANCHORAGES AND MOUNTING HARDWARE

- A. General:
- 1. Comply with Section 05 05 33, Anchor Systems, except as modified in this Section.
 - 2. Obtain bolts, nuts, and washers for connection of valve and appurtenances to concrete structure or other structural members from valve Supplier.

3. Bolts, nuts, and washers shall be of ample size and strength for purpose intended. Anchorages in concrete shall be at least 5/8-inch diameter.
4. Provide stem guide anchorages of required strength to prevent twisting and sagging of guides under load.
5. Materials: Provide bolts and washers of Type 316 stainless steel and nitrided nuts. Bolts shall have rolled threads. Bolts and nuts shall be electropolished to remove burrs.

2.10 TOOLS, LUBRICANTS, AND SPARE PARTS

- A. Provide the T-handle operating wrenches for buried valves.
- B. Lubricants: For valves, actuators, and appurtenances requiring lubricants, provide suitable lubricants for initial operation and for first year of use following Substantial Completion. Lubricants for equipment associated with conveying potable water or water that will be treated to become potable shall be food-grade and ANSI/NSF 61-listed.
- C. Tools, spare parts, and maintenance materials shall conform with Section 01 78 43, Spare Parts and Extra Materials.

2.11 PAINTING OF EXPOSED VALVES, HYDRANTS, AND APPURTENANCES

- A. Exterior steel, cast-iron, and ductile iron surfaces, except machined surfaces of exposed valves and appurtenances, shall be finish painted in manufacturer's shop. Surface preparation, priming, finish painting, and field touch-up painting shall conform to Section 09 91 00, Painting.

2.12 PAINTING OF BURIED VALVES

- A. Exterior steel, cast-iron, and ductile iron surfaces, except machined or bearing surfaces of buried valves, shall be painted in valve manufacturer's shop with two coats of asphalt varnish conforming to FS TT-C 494.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 1. Install valves and appurtenances in accordance with:
 - a. Supplier's instructions and the Contract Documents.
 - b. Requirements of applicable AWWA standards.
 - c. Applicable requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.
 3. Position swing check valves and butterfly valves so that, when valve is fully open, valve disc does not conflict with piping system elements upstream and downstream of valve.
- B. Exposed Valves:
1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
 2. Operators:
 - a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
 - b. Avoid placing operators at angles to floors or walls.
 - c. Orient chain operators out of way of walking areas.
 - d. Install valves so that indicator arrows are visible from floor level.
 - e. For motor-operated valves located lower than five feet above operating floor, orient motor actuator to allow convenient access to pushbuttons and handwheel.
 3. Floor Stands and Stems:
 - a. Install floor stands as shown and as recommended by manufacturer.
 - b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.
 - c. Provide sleeves where operating stems pass through floor. Extend sleeves two inches above floor.
- C. Buried Valves:
1. Install valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of box, or to undisturbed trench face if less than four feet.
 2. Provide flexible coupling next to each buried valve.
- D. Plug Valves:
1. Install plug valves that are in horizontal liquid piping with stem horizontal and plugs on top when valve is open. Plug shall be on upstream end when valve is closed.
 2. Install plug valves that are in vertical liquid piping with plug at top when closed or as recommended by valve Supplier.
 3. Supplier shall tag or mark plug valves to indicate proper mounting position.

3.3 FIELD QUALITY CONTROL

- A. Field Tests:
1. Adjust all parts and components as required to provide correct operation of valves.
 2. Conduct functional field test on each valve in presence of ENGINEER to demonstrate that each valve operates correctly.
 3. Verify satisfactory operation and controls of motor operated valves.

4. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.
5. Test ten percent of valves of each type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.

+ + END OF SECTION + +

SECTION 40 05 86

AIR VALVES FOR WATER AND WASTEWATER SERVICE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, and test Air Valves for water and wastewater service complete with appurtenances.
 - 2. This Section does not include valves used for:
 - a. Plumbing.
 - b. Heating, ventilating, air conditioning, steam, or condensate systems.
 - c. Instrumentation.
 - d. Sprinkler systems.
 - e. Chemical feed systems
 - f. Sewage sludge, process sludge, and grit
 - 3. This Section does not include:
 - a. Valves specified in other Sections
 - b. Valves furnished with equipment
 - c. Non-metallic valves.
- B. Coordination:
 - 1. Review installation procedures for this and other Specification sections and coordinate Work that must be installed with or before Work under this Section.
 - 2. If this is a multiple-prime contract project, provide timely advance notification of schedule of work to other contractors who may need to install items at same time or before Work included in this Section.
- C. Related Sections:
 - 1. Section 09 91 00, Painting
 - 2. Section 40 05 53, Process Valves, 4-inch Diameter and Larger

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/AWWA C512, Air Release, Air Vacuum and Combination Air Valves for Waterworks Service
 - 2. ANSI/AWWA C550, Protective Interior Coatings for Valves and Hydrants.
 - 3. ANSI/NSF 61 Drinking Water Components – Health Effects

1.3 DEFINITIONS

- A. The following definitions apply to this Section.

1. Air Release Valve: A hydromechanical device designed to automatically release to atmosphere small pockets of air as they accumulate in a pipeline when pipeline system is full and operating under pressure.
2. Air/Vacuum Valve: Direct-acting, float-operated, hydromechanical device designed to automatically release or admit large volumes of air during filling or draining of a pipeline or piping system. Valve will open to relieve negative pressures and will not reopen to vent air when system is full and under pressure.
3. Air Valve: Valve of one of the following types: Air Release Valve, Air/Vacuum Valve, or Combination Air Valve.
4. Combination Air Valve: Device having features of an Air Release Valve and Air/Vacuum Valve.
5. Maximum and Minimum Working Pressure: Pressure range at which valve is designed to function.
6. Orifice: Opening in valve mechanism through which air is expelled from or admitted into pipeline or piping system.
7. Valve Design Pressure: Maximum pressure to which a valve may be subjected without exceeding allowable stress of its components.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 1. Manufacturer shall be able to provide documentation of at least five installations of substantially similar equipment to that specified, in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 1. Valves of the same type, including specified accessories, shall be products of or furnished by a single air valve manufacturer.

1.5 SUBMITTALS

- A. Action Submittals.
 1. Product Data: Submit the following for each type and size of valve specified:
 - a. Product data sheet.
 - b. Complete catalog information, including dimensions, weight, performance data, Orifice size, specifications, and identification of materials of each part.
- B. Informational Submittals:
 1. Certifications:
 - a. Submit a certificate signed by manufacturer of each product stating that product conforms to applicable referenced standards and specified requirements.
 2. Test Reports:
 - a. Provide results of successful factory tests prior to shipping products to the Site.
 3. Manufacturer's Reports:
 - a. Submit written report of results of each visit to Site by a manufacturer's serviceman, including purpose and time of visit, tasks performed, and results obtained.

- C. Closeout Submittals.
 - 1. Operation and Maintenance Data:
 - a. Submit complete operation and maintenance manual for all Air Valves in the Contract, including maintenance data and schedules in sufficient detail for disassembly and assembly of valve, and identifying parts that can be replaced.
 - b. Furnish operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.
 - 2. Spare Parts:
 - a. Provide spare parts and list of recommended spare parts as specified in this Section:

1.6 DELIVERY, STORAGE, AND HANDING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Prepare valves for shipping per Section 6.2 of ANSI/AWWA C512.
 - 2. Conform to Section 01 65 00, Product Delivery Requirements.
- B. Acceptance at Site:
 - 1. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
- C. Storage and Protection:
 - 1. Keep all products off ground using pallets, platforms, or other supports. Protect products from corrosion and deterioration.
 - 2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

1.7 MAINTENANCE

- A. Extra Materials
 - 1. Furnish complete valves or sets of field replaceable parts for each type and size of valve installed, tagged and boxed for long-term storage as follows:

Quantity of Valves Installed	Spare Valves ⁽¹⁾ or Sets of Spare Parts ⁽²⁾
1 to 5	1
6 to 10	2
11 to 15	3
16 or more	5
Notes: (1) For valves smaller than 4-inch diameter furnish complete valve instead of sets of spare parts. Complete valve does not include accessories that are not typically furnished with valve model. (2) Set of field-replaceable spare parts includes one gasket and all field-replaceable seats and bushings.	

PART 2 – PRODUCTS

Home Depot MPS and FM
 Air Valves for Water and
 Wastewater Service
 30036073

2.1 GENERAL

- A. Extent:
 - 1. Provide valves included in this Section, per the schedule included in this Section and as shown on the Drawings.
- B. Requirements:
 - 1. Valve Design Pressure: Unless otherwise specified, Valve Design Pressure shall be equal to or exceed design pressure of pipe or equipment on which the valve is installed.
 - 2. Valve Type, Service, Inlet Size, Orifice Size, Accessories, and Required Features: Provide per the schedule in this Section.
 - 3. Materials: Air Valve materials shall be suitable for long-term use in the service specified.
 - 4. Ends:
 - a. Provide per the schedule in this Section.
 - b. Comply with valve connection requirements in Section 4.3 of ANSI/AWWA C512.
 - 5. Operating Pressure Range: Valves shall be suitable for pressure range specified in the schedule in this Section. Valve Design Pressure shall be greater than the valve's Maximum and Minimum Working Pressure.
 - 6. Air Valves in water service shall comply with ANSI/AWWA C512 unless otherwise shown or specified.
- C. Markings:
 - 1. Mark valves per Section 6.1 of ANSI/AWWA C512.
- D. Manufacturers and Model Numbers:
 - 1. Valve manufacturers and model numbers are in the schedule included in this Section.

2.2 ACCESSORIES

- A. Isolating Valves:
 - 1. Provide isolating valves in the schedule included in this Section and as shown. Isolating valves shall conform to applicable requirements of Sections 40 05 53, Process Valves, 4-inch Diameter and Larger.
 - 2. Valve Design Pressure of isolating valve shall equal or exceed Valve Design Pressure of the connected Air Valve.
- B. Back-flush Attachments:
 - 1. Unless otherwise indicated, provide back-flush attachment for Air Valves in sewage service.
 - 2. Back-flush attachments shall be as normally furnished by specified Air Valve manufacturer. Provide ports in the Air Valve body for flushing and discharge, each with an isolating valve and quick-connect for attaching hoses.
 - 3. Provide five-foot length of rubber hose with quick-connect for connecting to flushing discharge port.
 - 4. Provide a plugged 2-inch diameter NPT port at bottom of Air Valve body for removal of solids.

- C. Vacuum Check Valves:
 - 1. Provide vacuum check valves for Air Release Valves where indicated.
 - 2. Vacuum check valves shall be as normally furnished by Air Valve manufacturer.
- D. Throttling Devices
 - 1. Provide throttling device on discharges of Air/Vacuum Valves where indicated.
 - 2. Throttling device shall have a field-adjustable Orifice and be as normally furnished by Air Valve manufacturer.

2.3 FACTORY PAINTING

- A. Interior Surfaces
 - 1. Extent: Paint ferrous surfaces except stainless steel surfaces.
 - 2. Paint: Paint shall be as normally provided by Air Valve manufacturer for the specified application, except for potable water service valves which shall be coated with paint complying with ANSI/AWWA C550 and ANSI/NSF-61.
- B. Exterior Surfaces
 - 1. Exterior surfaces of cast-iron, ductile iron, and steel other than stainless steel, except machined surfaces of valves and appurtenances, shall be finish painted.
 - 2. Surface preparation, painting, and field touch-up painting shall be per Section 09 91 00, Painting.
 - 3. Furnish valve with only a prime coat if so indicated.

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect Air Valves per Section 5 of ANSI/AWWA C512. Do not ship valves that are not successfully tested.

PART 3- EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected.
- B. Examine valves and remove packing and foreign materials from interior of valve. Report defects to ENGINEER

3.2 INSTALLATION

- A. Install valves and appurtenances as shown on the Drawings and per Air Valve manufacturer's recommendations, approved Shop Drawings, and applicable codes and standards.
- B. Install valves plumb and vertical.

- C. Install with an isolating valve. Remove isolating valve's operating handle or lever and deliver to OWNER.
- D. Adjust throttling devices, if provided, for smooth, non-slam and water hammer-free operation.

3.3 FIELD QUALITY CONTROL

- A. Provide services of qualified factory-trained service technicians to supervise, check, and approve air valve(s) installation.

+ + END OF SECTION + + +

SECTION 40 60 00

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEM

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. General requirements applicable to all Process Control and Instrumentation Work.
 - 2. General requirements for process control and instrumentation submittals.
- B. Interfaces to equipment, instruments, and other components:
 - 1. Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers, which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
 - 2. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional instruments, wiring, control system inputs/outputs, controls, interlocks, electrical hardware etc., which may be necessary to make a complete, functional installation based on the actual equipment furnished:
 - a. Make all changes necessary to meet the manufacturer's wiring requirements.
 - 3. Submit all such changes and additions to the OWNER and ENGINEER for acceptance as specified in the Contract Documents.
 - 4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the instrumentation and control systems are completely accounted for. Include any items indicated on the Drawings or in Specifications from another discipline in the scope of Work:
 - a. If a conflict between Drawings and Specifications is discovered, refer conflict to the OWNER and ENGINEER as soon as possible for resolution.
 - 5. Loop drawings:
 - a. Provide complete loop drawings for all systems, including packaged equipment furnished as part of a vendor furnished package, and for all pre-purchased equipment.
 - b. The form, minimum level of detail, and format for the loop drawings must match that of the sample loop drawings included in the Contract Documents.
 - c. The OWNER and ENGINEER are not responsible for providing detailed loop diagrams for Contractor furnished equipment.
- C. All instrumentation, and control equipment and systems for the entire project

to comply with the requirements specified in the Instrumentation and Control Specifications, whether referenced in the individual Equipment Specifications or not:

1. The requirements of the Instrumentation and Control Specifications apply to all Instrumentation and Control Work specified in other Specifications, including HVAC controls, packaged mechanical systems, Local Control Panels (LCPs), Vendor Control Panels (VCPs), etc.
2. Inform all vendors supplying instrumentation, control systems, panels, and/or equipment of the requirements of the Instrumentation and Control Specifications.
3. Contractor shall be responsible for informing all subcontractor's and/or suppliers of all applicable requirements as specified in the Contract Documents, including but not limited to programming, configuration, interface, and other requirements described in this Section.
 - a. OWNER shall not be responsible for any additional costs due to the failure of Contractor to notify all subcontractors and/or suppliers of the General Condition requirements.

D. Contract Documents:

1. General:
 - a. The drawings and specifications are complementary and are to be used together in order to fully describe the Work.
2. Specifications:
 - a. The Contract Documents govern the Work.
 - b. These requirements are in addition to all General Requirements specified in the Contract Documents.
3. Contract drawings:
 - a. The Instrumentation and Control Drawings show in a diagrammatic manner, the desired locations, and arrangements of the components of the Instrumentation Work. Follow the drawings as closely as possible, use professional judgment and coordinate with the other trades to secure the best possible installation, use the entire drawing set for construction purposes.
 - b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only, exercise professional judgment in executing the Work to ensure the best possible installation:
 - 1) The equipment locations and dimensions indicated on the Drawings and elevations are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all instrumentation and control equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
 - c. Installation details:
 - 1) The Contract Drawings include installation details showing means and methods for installing instrumentation and control equipment. For cases where typical details are not provided or compatible with an installed location, develop installation details that are necessary for completing the Work, and submit these

details for review by the ENGINEER.

- d. Schematic diagrams:
 - 1) All controls are shown de-energized.
 - 2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
 - 3) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
 - 4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
 - 5) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences indicated on the Drawings or in the Specifications. Combine all information and furnish a coordinated and fully functional control system.

E. Alternates/Alternatives:

- 1. Substitute item provisions as specified in the Contract Documents.

F. Changes and change orders:

- 1. As specified in the Contract Documents.

1.2 REFERENCES

A. Code compliance:

- 1. As specified in the Contract Documents:
 - a. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.
- 2. The following codes and standards are hereby incorporated into this Section:
 - a. American National Standards Institute (ANSI).
 - b. American Petroleum Institute (API):
 - 1) RP 550 - Manual on Installation of Refinery Instruments and Control Systems; Part II-Process Stream Analyzers; Section 5-Oxygen Analyzers.
 - 2) RP 551 - Process Measurement Instrumentation.
 - c. International Organization for Standardization (ISO):
 - 1) 9001 - Quality Management Systems - Requirements.
 - d. International Society of Automation (ISA):
 - 1) 5.1 - Instrumentation Symbols and Identification.
 - 2) 5.4 - Instrument Loop Diagrams.
 - 3) 20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
 - e. National Electrical Manufacturers Association (NEMA):
 - 1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
 - f. National Fire Protection Association (NFPA 79): Electrical Standard

- for Industrial Machinery.
- g. National Institute of Standards and Technology (NIST).
- h. Underwriters Laboratories, Inc. (UL):
 - 1) 508 - Standard of Safety for Industrial Control Equipment.
 - 2) 508A - Standard of Safety for Industrial Control Panels.

- B. Compliance with Laws and Regulations:
 - 1. As specified in the Contract Documents.

1.3 DEFINITIONS

- A. Definitions of terms and other electrical and instrumentation considerations in accordance with:
 - 1. Factory Mutual (FM).
 - 2. International Electrotechnical Commission (IEC).
 - 3. Institute of Electrical and Electronics Engineers (IEEE).
 - 4. International Society of Automation (ISA).
 - 5. International Organization for Standardization (ISO).
 - 6. National Electrical Code (NEC).
 - 7. National Electrical Manufacturers Association (NEMA).
 - 8. National Electrical Testing Association (NETA).
 - 9. National Fire Protection Association (NFPA).
 - 10. National Institute of Standards and Technology (NIST).
 - 11. Underwriters Laboratories (UL).
- B. Specific definitions:
 - 1. Control circuit: Any circuit operating at 120 volts alternating current (VAC) or direct current (VDC) or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
 - 2. Panel: An instrument support system that may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems.
 - 3. Power circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
 - 4. Signal circuit: Any circuit operating at less than 50 VAC or VDC, which conveys analog information or digital communications information.
 - 5. Digital bus: A communication network, such as PROFIBUS, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions, and diagnostic information.
 - 6. 2-Wire transmitter (loop powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Section, 2-wire transmitter refers to a transmitter that provides a signal such as 4 to 20 mA 24VDC regulation of a signal in a series circuit with an external 24 VDC driving potential:
 - 7. Fieldbus communications signal or both.
 - 8. Powered transmitters: A transmitter that requires a separate power

source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Section, the produced signal may be a 4 to 20 mA 24VDC signal, a digital bus communications signal, or both.

9. System supplier - As specified in ICSC Qualifications in the Quality Assurance article of this Section.
10. Modifications: Changing, extending, interfacing to, removing, or altering an existing circuit.

C. NEMA:

1. Type 1 enclosure in accordance with NEMA 250.
2. Type 2 enclosure in accordance with NEMA 250.
3. Type 3 enclosure in accordance with NEMA 250.
4. Type 3R enclosure in accordance with NEMA 250.
5. Type 3S enclosure in accordance with NEMA 250.
6. Type 3X enclosure in accordance with NEMA 250.
7. Type 3RX enclosure in accordance with NEMA 250.
8. Type 3SX enclosure in accordance with NEMA 250.
9. Type 4 enclosure in accordance with NEMA 250.
10. Type 4X enclosure in accordance with NEMA 250.
11. Type 5 enclosure in accordance with NEMA 250.
12. Type 6 enclosure in accordance with NEMA 250.
13. Type 6P enclosure in accordance with NEMA 250.
14. Type 12 enclosure in accordance with NEMA 250.
15. Type 12K enclosure in accordance with NEMA 250.
16. Type 13 enclosure in accordance with NEMA 250.

D. Acronym definitions:

1. ACB: Automatic current balance.
2. ATS: Automatic Transfer Switch.
3. CCS: The PCS central computer system (CCS) consisting of computers and software. The personal computer-based hardware and software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher-level control system software and functions.
4. DPDT: Double-pole, double-throw.
5. ES: Enterprise system: Computer based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
6. FAT: Factory acceptance test also known as Source Test.
7. HART: Highway addressable remote transducer.
8. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode, equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode, equipment is started or stopped, and valves are opened or closed through a control algorithm within the PLC software. In the Off mode, the equipment is prohibited from responding from the PLC control.
9. HMI: Human machine interface is a software application that presents information to an operator or user about the state of a process, and to

- accept and implement the operators control instructions. Typically, information is displayed in a graphical format.
10. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
 11. IJB: Instrument junction boxes: A panel designed with cord sets to easily remove, replace, or relocate instrument signals.
 12. I/O: Input/Output.
 13. IP: Internet protocol or ingress protection.
 14. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
 15. LAN: Local area network: A control or communications network that is limited to the physical boundaries of the facility.
 16. LOI: Local Operator Interface is an operator interface device consisting of an alphanumeric or graphic display with operator input functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface.
 17. LOR: Local-Off-Remote control function. In the Remote mode, equipment is started or stopped, and valves are opened or closed through the PLC based upon the selection of the HOA. In the Local mode, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
 18. NJB: Network junction box. An enclosure that contains multiple access points to various networks within the facility. Networks could be Ethernet, Ethernet/IP, Fieldbus, RIO, etc.
 19. P&ID: Process and instrumentation diagram.
 20. PC: Personal computer.
 21. PCIS: Process control and instrumentation system: Includes the entire instrumentation system, the entire control system, and all of the Work specified in the Instrumentation and Control Specifications and depicted on the Instrumentation Drawings. This includes all the PCS and instruments and networking components as well as the various servers, workstations, thin clients, etc.
 22. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
 23. PCS: Process Control System: A general name for the computerized system that gathers and processes data from equipment and sensors and applies operational controls to the process equipment. It includes the PLCs and/or RIOs, LOIs, HMIs, both LCPs, VCPs and all data management systems accessible to staff.
 24. PJB: Power junction box: An enclosure with terminal blocks that distribute power to multiple instruments.
 25. PLC: Programmable logic controller.
 26. PS: Power supply.
 27. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.

28. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
29. SCADA: Supervisory control and data acquisition system: A general name for the computerized system that gathers and processes data from sensors and equipment located outside of the facility, such as wells, lift stations, metering stations, etc.
30. SPDT: Single-pole, double-throw.
31. SPST: Single-pole, single-throw.
32. UPS: Uninterruptible power supply.
33. VCP: Vendor control panel: Control panels that are furnished with equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, LOI, HMI, etc.
34. WAN: Wide area network: A control or communications network that extends beyond the physical boundaries of the facility.

1.4 SUBMITTALS

- A. Furnish submittals as specified below and in the Contract Documents.
- B. General:
 1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
 2. Furnish the submittals required by each section in the Instrumentation Specifications.
 3. Adhere to the wiring numbering scheme:
 - a. Uniquely number each wire.
 - b. Wire numbers must appear on all Equipment Drawings.
 4. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.
- C. Submittal organization:
 1. First page:
 - a. Specification section reference.
 - b. Name and telephone number of individuals who reviewed submittal before delivery to ENGINEER.
 - c. Name and telephone number of individuals who is primarily responsible for the development of the submittal.
 - d. Comments.
 - e. Contractor's review certification statement and signature.
 2. Next pages:
 - a. Provide confirmation of specification compliance:
 - 1) Specification section: Include with each submittal a copy of the relevant specification section.
 - a) Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (✓) or deviation with a consecutive number (1, 2, 3).
 - b) Provide a list of all numbered deviations with a clear explanation and reason for the deviation.

- b. Include a response in writing to each of the ENGINEER's comments or questions for submittal packages which are re-submitted:
 - 1) In the order that the comments or questions were presented throughout the submittal.
 - 2) Referenced by index section and page number on which the comment appeared.
 - 3) Acceptable responses to ENGINEER's comments are either:
 - a) ENGINEER's comment or change is accepted, and appropriate changes are made.
 - b) Explain why comment is not accepted or requested change is not made.
 - c) Explain how requirement will be satisfied in lieu of comment or change requested by ENGINEER.
 - 4) Any re-submittal, which does not contain responses to the ENGINEER's previous comments shall be returned for Revision and Re-submittal.
 - 5) No further review by the ENGINEER will be performed until a response for previous comments has been received.
 - 3. Remaining pages:
 - a. Actual submittal data:
 - 1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
 - 2) For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is intended to be used.
- D. Submittal requirements:
- 1. Furnish submittals that are fully indexed with a tabbed divider for every component.
 - 2. Sequentially number pages within the tabbed sections. Submittals and operation and maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
 - 3. Furnish submittals in the following general order, each in a separate bound set:
 - a. Schedule of Values.
 - b. Product Data.
 - c. After ENGINEER acceptance of the Product Data, submit the Project Shop Drawing submittals.
 - d. Loop Description Submittal.
 - e. The Process Control Hardware and Software Submittal including control system software, programming, and screens.
 - f. Testing, Calibration and Process Start-Up procedures.
 - g. Operation and Maintenance Data.
 - h. Training Submittals.
 - i. Record Documents.
 - 4. Edit all submittals and operation and maintenance manuals so that the submittal specifically applies to only the equipment furnished.
 - a. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information

remaining is only applicable to the equipment being furnished.

5. Submit copies of shop drawings, and product data:
 - a. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
6. Where submittals are required, provide a separate submittal for each specification section. In order to expedite construction, the Contractor may make more than 1 submittal per specification section, but a single submittal may not cover more than 1 specification section:
 - a. The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section. (For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.).
7. Exceptions to Specifications and Drawings:
 - a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
 - b. If there is insufficient explanation for the exception or deviation, the submittal will be returned requiring revision and re-submittal.
 - c. Acceptance of any exception is at the sole discretion of the ENGINEER.
 - 1) Provide all items (materials, features, functions, performance, etc.) required by the Contract Documents that are not accepted as exceptions.
 - d. Replace all items that do not meet the requirements of the Contract Documents, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.

E. Submittal preparation:

1. During the period of preparation of submittals, the Contractor shall authorize direct, informal liaison between the ICSC and the ENGINEER for exchange of technical information. As a result of this liaison, certain minor refinements and revisions may be authorized informally by the ENGINEER, which do not alter the scope of Work or cause increase or decrease in the Contract price or times. During this informal exchange, no oral statement by the ENGINEER shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant exception to, or variation from, these Contract Documents.
2. In these Contract Documents, some items of Work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ISA-5.1:
 - a. Employ the nomenclature and numbers designated in this Section and indicated on the Drawings exclusively throughout shop drawings, data sheets, and similar submittals.
 - b. Replace any other symbols, designations, and nomenclature unique to a manufacturer's, suppliers, or subcontractor's standard methods with those identified in this Section and indicated on the Drawings.

F. Specific submittal requirements:

1. Shop drawings:
 - a. Required for materials and equipment listed in this and other sections.
 - b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
 - c. Shop drawings requirements:
 - 1) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
 - 2) Locations of conduit entrances and access plates.
 - 3) Component layout and identification.
 - 4) Schematic and wiring diagrams with wire numbers and terminal identification.
 - 5) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
 - 6) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
 - 7) Weight.
 - 8) Finish.
 - 9) Nameplates:
 - 10) As specified in Section 26 05 53 - Identification for Electrical Systems or as indicated on the Drawings.
 - 11) Temperature limitations, as applicable.
 - d. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
 - e. Adhere to wiring numbering scheme outlined in Section 26 05 53 - Identification for Electrical Systems throughout the Project:
 - 1) Uniquely number each wire per the Specifications.
 - f. Wire numbers must appear on all equipment drawings.
 - g. Organize the shop drawing submittals for inclusion in the Operation and Maintenance Manuals:
 - 1) Furnish the initial shop drawing submittal bound in one or more standard size, 3-ring, D-ring, loose-leaf, vinyl plastic, hard-cover binders suitable for bookshelf storage.
 - 2) Binder ring size: 2 inches.
 - h. Include the letterhead and/or title block of the firm responsible for the preparation of all shop drawings. Include the following information in the title block, as a minimum:
 - 1) The firm's registered business name.
 - 2) Firm's physical address, email address, and phone number.
 - 3) OWNER's name.
 - 4) Project name and location.
 - 5) Drawing name.
 - 6) Revision level.
 - 7) Personnel responsible for the content of the drawing.
 - 8) Date.
 - i. The work includes modifications to existing circuits:

- 1) Clearly show all modifications to existing circuits.
 - 2) In addition, show all existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
2. Product data:
 - a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
 - b. Include:
 - 1) Catalog cuts.
 - 2) Bulletins.
 - 3) Brochures.
 - 4) Quality photocopies of applicable pages from these documents.
 - 5) Identify on the data sheets the Project name, applicable specification section, and paragraph.
 - 6) Identify model number and options for the actual equipment being furnished.
 - 7) Neatly cross out options that do not apply or equipment not intended to be supplied.
 - c. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
 - d. Adhere to wiring numbering scheme outlined in Section 26 05 53 - Identification for Electrical Systems throughout the Project:
 - 1) Uniquely number each wire per the Specifications.
 - e. Wire numbers must appear on all equipment drawings.
3. Detailed sequence of operation for all equipment or systems.
4. Operation and maintenance manuals:
 - a. Submit preliminary sets of these manuals to the ENGINEER for review of format and content:
 - 1) ENGINEER will return 1 set with comments.
 - 2) Revise and/or amend as required and submit the requisite number of copies to the ENGINEER 15 days before Functional Testing of the systems.
 - b. Incorporate changes that occur during process start-up and submit as part of the final manuals.
 - c. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
 - d. Include Record Documents and the accepted shop drawing submittals, modified for conditions encountered in the field during the work.
 - e. Include signed results from Functional Testing and Process Operational Period.
 - f. Provide installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.
 - g. Provide exploded or other detailed views of all instruments, assemblies, and accessory components together with complete parts lists and ordering instructions.
 - h. Spare parts list:

- 1) Include a priced list of recommended spare parts for all the equipment furnished under this Contract:
 - a) Include recommended quantities sufficient to maintain the furnished system for a period of 5 years.
- 2) Annotate the list to indicate which items, if any and quantity are furnished as part of this Contract.
- i. Provide the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts.
- j. Additional operation and maintenance manual requirements:
 - 1) Completely index manuals with a tab for each section:
 - a) Each section containing applicable data for each piece of equipment, system, or topic covered.
 - b) Assemble manuals using the accepted shop drawings, and include, the following types of data:
 - (1) Complete set of 11-inch by 17-inch drawings of equipment.
 - (2) Complete set of 11-inch by 17-inch drawings of the control system.
 - (3) Complete set of control schematics.
 - (4) Complete parts list for all equipment being provided.
 - (5) Catalog data for all products or equipment furnished.
- k. Operational Manual:
 - 1) Prepare and provide a simplified version of the standard manufacturer's HMI software and system operations manual that includes basic instructions in the application of the system as required for operators in day-to-day operations.
- l. Control System Software Record Documents:
 - 1) Include complete documentation of all the software programs provided for the entire control and PCS system, including:
 - a) Listings of all application software on both hard copy and USB flash drive.
 - (1) Database, both hard copy and USB flash drive.
 - (2) Communication protocols.
 - (3) All documentation necessary to maintain, troubleshoot, modify, or update the software system.
- m. Organize the operation and maintenance manuals for each process in the following manner:
 - 1) Section A - Process and Instrumentation Diagrams.
 - 2) Section B - Control Descriptions.
 - 3) Section C - Loop Drawings.
 - 4) Section D - Instrument Summary.
 - 5) Section E - Instrument Data Sheets and Brochures.
 - 6) Section F - Sizing Calculations.
 - 7) Section G - Instrumentation Installation Details.
 - 8) Section H - Test Results.
 - 9) Section I - Operational Manual.
 - 10) Section J - Spare Parts List.
 - 11) Section K - Control System Software.

5. Material and equipment schedules:

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- a. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
 - 1) Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
6. Itemized instrument summary:
 - a. Submit a hard copy of the instrument summary.
 - b. List all of the key attributes of each instrument including:
 - 1) Tag number.
 - 2) Manufacturer.
 - 3) Model number.
 - 4) Service.
 - 5) Area location.
 - 6) Calibrated range.
 - 7) Loop drawing number.
 - c. Associated LCP, VCP, PCM, or PLC.
7. Instrument data sheets and cut sheets:
 - a. Furnish fully completed data sheets, both electronically in Microsoft Word or Excel and in hard copy, for each instrument and component according to ISA-20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. The data sheets provided with the instrument specifications are preliminary and are not complete. They are provided to assist with the completion of final instrument data sheets. Additional data sheets may be required. Include the following information on the data sheet:
 - 1) Component functional description specified in this Section and indicated on the Drawings.
 - 2) Manufacturers model number or other product designation.
 - 3) Tag number specified in this Section and indicated on the Drawings.
 - 4) System or loop of which the component is a part.
 - 5) Location or assembly at which the component is to be installed.
 - 6) Input and output characteristics, including digital bus communication.
 - 7) Scale range with units and multiplier.
 - 8) Requirements for electric supply.
 - 9) Requirements for air supply.
 - 10) Power consumption.
 - 11) Response timing.
 - 12) Materials of construction and of component parts that are in contact with, or otherwise exposed to, process media, and or corrosive ambient air.
 - 13) Special requirements or features, such as specifications for ambient operating conditions.
 - 14) Features and options that are furnished.
 - b. Provide a technical brochure or bulletin ("cut sheet") for each instrument on the project. Submit with the corresponding data sheets:
 - 1) Where the same make and model of instrument is used in 2 or

- more applications on the project, and the process applications are nearly identical, and the materials, features and options are identical submit one brochure or bulletin for the set of identical instruments.
- 2) Include a list of tag numbers for which it applies with each brochure or bulletin.
 - 3) Furnish technical product brochures that are complete enough to verify conformance with all Contract Document requirements, and to reflect only those features supplied with the device.
 - 4) Cross out models, features, options, or accessories that are not being provided.
 - 5) Clearly mark and identify special options and features.
 - c. Organization: Index the data sheets and brochures in the submittal by systems or loops.
8. Control panel hardware submittal:
- a. Submit the following in 1 submittal package.
 - b. Complete and detailed bills of materials:
 - 1) Including quantity, description, manufacturer, and part number for each assembly or component for each control panel.
 - 2) Include all items within an enclosure.
 - c. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and Control System equipment.
 - d. Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium voltage power cables.
 - e. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.
 - f. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
 - 1) The manufacturer's model number or other identifying product designation.
 - 2) Tag and loop number.
 - 3) System to which it belongs.
 - 4) Site to which it applies.
 - 5) Input and output characteristics.
 - 6) Requirements for electric power.
 - 7) Device ambient operating requirements.
 - 8) Materials of construction.
9. Installation recommendations:
- a. Submit the manufacturer's printed recommendations for installation of instrumentation equipment.
10. Training submittals:
- a. Develop and submit for review a general training plan for approval by OWNER within 14 calendar days from Notice to Proceed. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with

- resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer- based training, etc.).
 - b. The ENGINEER or OWNER will review the general training plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the ENGINEER or OWNER, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system, provide more qualified instructors.
 - c. The general training plan and schedule shall be updated by the Contractor at the beginning of each Phase and approved by the OWNER a minimum of 30 days prior to commencement of training.
 - d. Training course plan submittals:
 - 1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson as specified the Contract Documents.
 - 2) Describe any student pre-requisites for the course or training activity.
 - 3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.
 - 4) Submit training materials.
 - e. Incorporate all submittal review comments into the course.
 - f. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.
11. Project Record documents:
- a. Furnish as specified in the Contract Documents.
 - b. Record Drawing requirements:
 - 1) Provide Project Record Drawing of all Instrumentation Drawings.
 - 2) Update Record Drawings weekly.
 - 3) Record Drawings must be fully updated as a condition of the monthly progress payments.
 - 4) Clearly and neatly show all changes including the following:
 - a) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
 - c. Shop drawings:
 - 1) General:
 - a) Coordinate all aspects of the Work so that a complete, instrumentation, computer, and control system for the facility is supported by accurate shop and record drawings:
 - (1) Clearly show every wire, circuit, and terminal provided under this contract on one or more submitted wiring diagrams.
 - b) Show all interfaces between any of the following: instruments, vendor control panels, motor control centers, motor starters, variable speed drives, control valves, flow meters, chemical feeders, digital bus network

- equipment, and other equipment related to the PCS.
 - c) Generate all drawings developed for this project utilizing commercial CAD software:
 - (1) Furnish on USB flash drives containing the following for each drawing:
 - (a) Original CAD files in native and DWG format as applicable.
 - (b) PDF version.
 - (2) Provide hard copies on 11-inch by 17-inch plain bond paper.
 - d) Upon completion of the Work, update all shop drawings to indicate the final as-built configuration of the systems:
 - (1) Should an error be found in a shop drawing during installation or process start-up of equipment, note the correction, including any field changes found necessary, on the drawing and submit the corrections in the Record Documents.
 - (2) Update, check, and revise all wiring drawings and other submitted drawings and documents to show final installed conditions.
 - (3) Provide as-built shop drawings for all instrumentation equipment on 11-inch by 17-inch using plain bond paper.
 - (4) Provide electronic copies of these documents on USB flash drive in native and DWG format and PDF format. Size all drawings to be readable and legible on 11-inch by 17-inch media.
 - e) Submittal Documents:
 - (1) Provide an interim submittal of Record Documents after the PCS system Functional Testing.
 - (2) Submit final Record Documents before Substantial Completion or earlier if so, specified in the Contract Documents.
 - f) Review and Corrections:
 - (1) Correct any Record Documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
 - (2) Promptly correct and re-submit Record Documents returned for correction.
- 2) Furnish written information prepared specifically for this Project using Microsoft Word and PDF formats and printed on 8.5-inch by 11-inch plain bond paper:
 - a) Provide electronic copies of these documents on USB flash drives.
 - b. Review and corrections:
 - 1) Correct any record documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
 - 2) Promptly correct and re-submit record documents returned for correction.

12. Loop Drawings:

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- a. Submit loop drawings for every analog, discrete, and fieldbus signal and control circuit:
 - 1) Provide a loop drawing submittal that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop on this Project.
 - 2) This requirement applies to all signal and control circuits associated with equipment on this Project including vendor supplied equipment packages and control panels.
 - 3) Provide loop drawings in the format indicated in the contract drawings. Provide all tagging in accordance with the OWNER's standard.
 - b. Show every instrument and I/O point on at least one loop diagram.
 - c. Provide a complete index in the front of each bound volume:
 - 1) Index the loop drawings by systems or process areas.
 - d. Provide drawings showing definitive diagrams for every instrumentation loop system:
 - 1) Show and identify each component of each loop or system using requirements and symbols from ISA-5.4.
 - 2) Furnish a separate drawing sheet for each system or loop diagram.
 - e. In addition to the ISA-5.4 requirements, show the following details:
 - 1) Functional name of each loop.
 - 2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
 - 3) Show all terminal numbers, regardless of the entity providing the equipment.
 - 4) MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.
 - 5) Designation of and, if appropriate, terminal assignments associated with, every manhole, pull-box, junction box, conduit, and panel through which the loop circuits pass.
 - 6) Show vendor control panel, instrument panel, conduit, junction box, equipment and PCS terminations, termination identification, wire numbers and colors, power circuits, and ground identifications.
 - 7) If a circuit is continued on another drawing, show the name and number of the continuation drawing on the loop drawing. Provide complete references to all continuation drawings whether vendor control panels, other loop drawings, existing drawings provided by the OWNER, or other drawings.
 - f. In addition to the above requirements, provide loop diagrams in accordance with the example loop diagram as indicated on the Drawings.
13. Instrument Installation Drawings:
- a. Submit, instrument installation, mounting, and anchoring details for all components and assemblies, including access requirements and conduit connection or entry details.
 - b. Furnish for each instrument a dedicated 8 1/2-inch by 11-inch installation detail that pertains to the specific instrument by tag number.

- c. For each detail, provide certification and the hard copies, by the instrument manufacturer, that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable.
 - d. For each detail, provide, as a minimum, the following contents:
 - 1) Necessary sections and elevation views required to define instrument location by referencing tank, building or equipment names and numbers, and geographical qualities such as north, south, east, west, basement, first floor, etc.
 - 2) Ambient temperature and humidity where the instrument is to be installed.
 - 3) Corrosive qualities of the environment where the instrument is to be installed.
 - 4) Hazardous rating of the environment where the instrument is to be installed.
 - 5) Process line pipe or tank size, service and material.
 - 6) Process tap elevation and location.
 - 7) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
 - 8) Routing of tubing and identification of supports.
 - 9) Mounting brackets, stands, anchoring devices, and sunshades.
 - 10) Conduit entry size, number, location, and delineation between power and signal.
 - 11) NEMA ratings of enclosures and all components.
 - 12) Clearances required for instrument servicing.
 - 13) List itemizing all manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.
14. Control Panel Drawings:
- a. Layout Drawings:
 - 1) Submit panel, enclosure, console, furniture, and cabinet layout drawings for all items provided.
 - 2) As a minimum, include the following information:
 - a) To scale front, side, and plan views.
 - b) Dimensions.
 - c) Interior and exterior arrangements.
 - d) Mounting information, including conduit entrance location.
 - e) Finish data.
 - f) Tag number and functional name of items mounted in and on each panel, console, and cabinet.
 - g) Nameplate legend including text, letter size, materials, and colors.
 - b. Wiring and piping diagrams:
 - 1) Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
 - 2) Include the following information:
 - a) Name of panel.
 - b) Wiring and piping sizes and types.

- c) Terminal strip numbers.
 - d) Wire tags and labels.
 - e) Functional name and manufacturer's designation for items to which wiring and piping are connected.
 - f) Electrical control schematics in accordance with ANSI standards.
- c. Installation drawings:
 - 1) Provide site-specific installation drawings for all control equipment panels, including dimensions.
 - 2) Provide scaled drawings and show the position of the equipment at its intended installation location.
 - 3) Show the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.
 - 4) Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.
- 15. Schematic Diagrams:
 - a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
 - b. Include device and field connection terminal numbers on all schematic diagrams.
 - c. Incorporate equipment manufacturer's shop drawing information into the schematic diagrams in order to document the entire control system.
- 16. Control System Diagram:
 - a. Submit a complete set of control system diagrams including the following information:
 - 1) All PLCs, workstations, printers, communication devices, and communication links:
 - a) Show all PLCs with their current I/O allocation, and future I/O allocation, current plus spares provided, and maximum potential I/O based on available slots.
 - 2) All cables required for communication requirements.
 - 3) Show each component fully annotated with conduit size and number associated with the power source.
- 17. Process Control Software Submittal:
 - a. In accordance with Product Data and Shop Drawing general requirements.
 - b. Submit a complete description of the standard application software programs, operating system and utility programs, including modifications and explanation of how the specific functional requirements are met:
 - 1) Provide a cross-reference between the Specification requirements and the software submittal, in order to provide the ENGINEER, the ability to identify how each specified requirement or function is met.
 - c. A complete listing of the PCS system points I/O database:
 - 1) Include for each data point, relevant parameters such as range,

- contact orientation, limits, incremental limits, I/O card byte, I/O hardware address, and PLC assignment.
 - 2) Organize on a site-by-site basis, separate by point type.
 - 3) In addition to the active I/O points, list the implemented spare I/O points and the available I/O points remaining on each card, as well as other defined future points specified or shown.
 - 4) Upon completion of the Work, update all I/O lists to indicate the final as-built configuration of the systems:
 - a) Organize as-built I/O list on a site-by-site basis, separated by equipment and point type.
 - d. Detailed descriptions of procedures used to implement and modify control strategies and database construction.
 - e. Preliminary overview, screens, station graphic displays, and preliminary reports.
 - f. Refer to Section 40 68 00 - Control Systems: PCS Software for additional requirements.
- 18. Instrumentation and Control System Contractor Statement of Qualifications:
 - a. Submit statement of qualifications of the proposed ICSC in accordance with subsequent requirements of this Section.
- 19. Control Descriptions:
 - a. For each control loop, provide a detailed functional description of the operation of the equipment, signals, and controls as shown on the P&IDs:
 - 1) Include all functions depicted or described in the Contract Documents.
 - 2) Include within the Control Description content:
 - a) All specific requirements.
 - b) All common requirements that pertain in general to all loops.
 - c) Listing all ranges, setpoints, timers, values, counter values, etc.
- 20. Test Procedure Submittals:
 - a. Submit the proposed procedures to be followed during tests of the PCS and its components in 2 parts:
 - 1) Preliminary Submittal: Outline of the specific proposed tests and examples of proposed forms and checklists.
 - 2) Detailed Submittal: After successful review of the Preliminary Submittal, submit the proposed detailed test procedures, forms, and checklists. Include a statement of test objectives with the test procedures.
- 21. Test reports:
 - a. Include the following:
 - b. A description of the test.
 - 1) List of equipment used.
 - 2) Name of the person conducting the test.
 - 3) Date and time the test was conducted.
 - 4) All raw data collected.
 - 5) Calculated results.

- 6) Each report signed by the person responsible for the test.
22. Calculations:
- a. Where required by specific Instrumentation Specifications:
 - 1) Because these calculations are being provided by a registered professional ENGINEER, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculation means.

1.5 QUALITY ASSURANCE

A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.

B. ICSC qualifications:

1. General information on the proposing company:
 - a. Document that the ICSC Company has been actively involved in the instrumentation, PLC-based control systems business for a minimum of five years and has adequate facilities, organization structure, manpower, and technical and managerial expertise to properly perform the Work as specified in these Specifications.
 - b. For construction estimates in excess of \$2 Million of work, submit a financial prospectus indicative of the corporation's financial state. This prospectus shall also include:
 - 1) A letter from a financial institution indicating a current line of credit and bonding limit which can be applied to this Project.
 - 2) Latest annual report or reviewed financial statement.
 - 3) ICSC shall submit documentation showing that they are able to bond all work.
2. Document that the ICSC has a qualified permanent service facility:
 - a. Said facility shall be staffed with permanent employees and equipped with the tools and test equipment necessary to calibrate, test, and process start-up all of the instrumentation, control, telemetry, SCADA and control systems hardware and software furnished under this Contract, including remote diagnostic capability.
 - b. Document in-house resource of permanent personnel experienced in the design and programming of equipment and systems as specified in these Specifications.
 - 1) Submit a list of individuals assigned to the project.
 - c. Document the existence of a training program staffed by qualified instructors, to provide proper training in the operation and maintenance of equipment as specified in these Specifications.
 - d. Document that the firm is a recognized or certified "system integrator partner" or similar designation for the control software and PLC system being supplied for this Project, e.g. Wonderware Certified Developer / System Integrator Partner.
3. Similar project experience of the company:
 - a. Provide a list of at least 3 successfully completed projects for a water

and/or wastewater system of similar scope and complexity in which the proposing firm used components the same as those intended for use on this Project. The proposing firm must have performed, for each listed project, system engineering, system fabrication and installation, documentation (including schematic, wiring and panel assembly drawings), software configuration and documentation, field testing, calibration and process start-up, operator instruction, and maintenance training. In addition, provide the following information for each project:

- 1) Name of plant or system OWNER contact name, and current telephone number. Design ENGINEER's name, address, and telephone number. Failure to provide current contact information may result in the listed project being disqualified for use in meeting the minimum requirements for qualification.
 - 2) Manufacturer and model number(s) of the PLC based control system and the computer-based SCADA system used for both hardware and software.
 - 3) Brief description of the system.
 - 4) Approximate number of input and output signals: analog, digital, and fieldbus.
 - 5) Brief application software description.
 - 6) Contracted cost of the system separate by base amount and any change orders for the completed projects.
 - 7) Duration of the project and date of completion.
4. Information on the proposed Project team members:
- a. Provide the name and resume of the individual persons who will be responsible for each of the following:
 - 1) Office engineering and management of this Project.
 - 2) Lead for software configuration/programming.
 - 3) Individual who will be responsible for the hardware and hardware interface design.
 - 4) Individual who will be responsible for field testing, calibration, and process start-up.
 - 5) Individual who will be responsible for operator training.
 - b. All of these individuals must be permanent employees of the proposing firm.
5. Information on the PCS system to be supplied:
- a. A proposed system block diagram detailing the system configuration.
 - b. Description and specifications of the major equipment components to be furnished for the PCS system. Include the following as a minimum:
 - 1) PCs.
 - 2) PLCs.
 - 3) CPUs.
 - 4) RTUs.
 - 5) Printers.
 - 6) CRTs.
 - 7) Servers.
 - 8) Network equipment.

- 9) Modems.
 - 10) Radios.
 - 11) Any other electrical or electronic equipment costing more than \$5,000.
- c. A brief description of the proposed PCS software's features.
- d. Supporting descriptive information, calculations, etc., to facilitate a complete evaluation.
- e. A clear statement on a separate page that the proposed system is as specified in the Specifications in terms of performance, reliability, and manufacturer's support.
- 6. Certification of scope of supply:
 - a. Provide a clear description of the proposed (minimum) scope of supply for the proposing ICSC firm. This scope description shall be binding and shall be considered the minimum scope of work for the proposing firm. The intent is to verify that proposing firms can and will perform the complete, minimum scope of the ICSC described above. Additions to this minimum scope of supply are allowed if they do not violate other requirements of the Contract Documents.
 - b. Execute and submit a written certification of intent to assume full responsibility for the complete requirements of the Instrumentation and Control Specifications and related Instrumentation Drawings.
 - c. The certification shall be typed on the firm's letterhead and signed by an authorized representative of the firm.
- 7. It is the responsibility of the firm to furnish sufficient information of each item to document compliance with the minimum requirements.
- 8. Determination of the proposed ICSC qualifications is at the sole discretion of the ENGINEER and OWNER.

C. Qualification minimum requirements:

- 1. To be Qualified as an ICSC, a proposing company must meet the minimum requirements set forth in the following list based on the information submitted. For joint ventures, both firms must separately meet the requirements.
- 2. Firm has been in business at least 10 years.
- 3. Firm has been performing PCS system integration services for at least 5 years.
- 4. Firm has been supplying PCS systems to the water and wastewater industries for at least 5 years.
- 5. Firm must have an I&C business volume of at least \$2.0 million, annually.
- 6. Firm and officers do not have adverse criminal or legal records, such as criminal convictions, defaults, loss of licenses, etc.
- 7. Firm does not have a poor project performance record, such as repeated claims, litigation, defaults, etc.
- 8. Firm demonstrates completion of at least 3 similar (water or wastewater) projects in the past 5 years. Each similar project must include:
 - a. Project PCS system cost of at least 1/2 of this Project estimated cost.
 - b. Number of new physical IO points at least 75 percent of the new physical IO count of this Project.
 - c. Same PLC hardware or PCS software as this Project.

- d. Water or wastewater facility.
 - e. At least roughly 2/3 the number of PLCs as the current project PLCs (with CPUs), or greater.
 - f. At least 1 operator stations, or greater.
 - g. Date completed. "Completion" means the similar project has been installed and is substantially complete.
 - 9. Firm must have their own operating UL listed panel fabrication and testing facility.
 - 10. Proposed personnel have adequate experience and credentials, including:
 - a. PM and PE have served in similar roles on at least 1 comparable project(s) in the past 5 years.
 - b. Lead programmer has a minimum of 5 years of experience on similar projects.
 - c. Firm has an in-state registered electrical or control system ENGINEER located in the local office who will be an active and significant member of the project team and who will stamp all drawings produced by the firm for this Project.
 - 11. Firm cannot be in bankruptcy.
 - 12. The financial condition of the firm cannot be such that its financial ability to complete the Project is, in the opinion of the OWNER, in doubt.
 - 13. Firm must have a minimum of 20 permanent, full-time technical employees, all of whom must be regularly engaged in I&C/PCS design and implementation work.
 - 14. Firm must have a permanent local office within 250 miles of the Project Site that is staffed with at least 5 technical employees (administrative staff does not count) and has been so staffed for the past 12 months.
 - 15. The proposed equipment, software, and systems must comply with the requirements of the Drawings and Specifications.
- D. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the ENGINEER and the Authority Having Jurisdiction.
- E. The ICSC must have their own operating UL listed panel fabrication facility. All panels must be fabricated at this facility and meet all UL 508/508A requirements.
- F. ICSC:
- 1. Contractor, through the use of a qualified ICSC, is responsible for the implementation of the PCIS and the integration of the system with other required instrumentation, control devices, and software.
 - 2. The ICSC assumes full responsibility, through the Contractor, to perform all work to select, furnish, install, program, test, calibrate, and place into operation all instrumentation, controls, telemetry equipment, control panels, and control system including application software, for a complete, integrated and functional PCIS system.
 - 3. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these Specifications that the ICSC be responsible for the integration of the PCIS with existing devices and devices provided under the Contract Documents with the objective

of providing a completely integrated control system.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store all equipment and materials delivered to the job site in a location that will not interfere with the construction or the OWNER's operations.
- B. Shipping precautions:
 - 1. After completion of shop assembly, successful Source Test, pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy-duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
 - 2. Place dehumidifiers when required, inside the polyethylene coverings.
 - 3. Skid-mount the equipment for final transport.
 - 4. Provide lifting rings for moving without removing protective covering.
 - 5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.
- C. Special instructions:
 - 1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.
- D. Tagging:
 - 1. Tag each component and/or instrument to identify its location, instrument tag number, and function in the system.
 - 2. Firmly attach a permanent tag indelibly machine marked with the instrument tag number, as given in the tabulation, on each piece of equipment constituting the PCS.
 - 3. Tag instruments immediately upon receipt in the field.
 - 4. Prominently display identification on the outside of the package.
 - 5. Utilize the Tag and Loop Number identifications shown on the P&IDs.
- E. Delivery and inspection:
 - 1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.

1.7 PROJECT OR SITE CONDITIONS

- A. Site conditions:
 - 1. Provide a PCS, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
 - 2. Wind:
 - a. Provide all equipment and construction techniques suitable for the site wind loading criteria, as specified in the Contract Documents.
 - 3. Altitude, temperature and humidity:
 - a. As specified in the Contract Documents.
 - b. Provide all equipment and instrumentation fully rated for continuous

- operation at this altitude, temperature and humidity conditions with no additional derating factors applied.
- c. Provide additional temperature conditioning equipment to maintain all equipment and instrumentation in non-conditioned spaces or outdoors subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature as determined by the equipment manufacturer's guidelines:
 - 1) Provide all power wiring for these devices (e.g., heaters, fans, etc.), whether or not indicated on the Drawings.
 - 4. Area classifications:
 - a. Furnish enclosures that match the area classifications as specified in Contract Drawings and Division 26.
 - 5. Site security:
 - a. Abide by all security and safety rules concerning the Work on the Site as directed by the OWNER and as specified in the Contract Documents.

1.8 SEQUENCING

- A. General:
 - 1. As specified in the Contract Documents.
 - 2. Testing requirements are specified in the Contract Documents and 40 80 00- Commissioning for Instrumentation and Controls.
 - 3. General scheduling requirements are specified in the Contract Documents.
 - 4. Work restrictions and other scheduling requirements are specified in the Contract Documents.
 - 5. Commissioning requirements as specified in the Contract Documents.
- B. Submit proposed ICSC statement of qualifications:
 - 1. The ICSC must be accepted by the ENGINEER before any other Work commences.
- C. Pre-submittal conferences:
 - 1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.
 - 2. The Contractor, instrumentation and control subcontractor, electrical subcontractor, and all manufacturers furnishing major pieces of equipment must attend, including but not limited to:
 - a. Vendor control panels.
 - b. Chemical feed systems.
 - c. Motor control centers.
 - d. Switchgear.
 - e. Variable frequency drives.
 - f. Lighting.
 - g. Engine generators.

D. System configuration meetings:

1. Review the PLC configuration, PLC logic development, formatting, documentation etc. with the ENGINEER and OWNER on at least 3 occasions during development:
 - a. Preliminary meeting: Before configuration work is begun. The ICSC must bring to this meeting example of program structure, naming convention, add-on instructions, UDTs, peer to peer communication standards etc. to demonstrate design standards and coordination. PLC control logic shall use Allen-Bradley Add-On Instructions to the extent possible in conjunction with Wonderware standard objects. A narrative of the functional descriptions / control strategies of the process shall also be included for discussion.
 - a. Intermediate review meeting: Held after discussions and feedback from the preliminary meeting have been incorporated and an initial program structure and logic development scheme has been developed.
 - b. Pre-submittal review meeting: Submit an informal hardcopy of PLC design standards, Add-On instructions, etc., for review by the ENGINEER and OWNER to determine that requirements are being sufficiently met as per the PLC design standards.
 - c. Final review meeting: Held after initial completion of all configuration work. This final meeting may not be held in conjunction with the Source Test. Make final format revisions after this review. All PLC logic configuration codes and methods shall be documented in County PLC and HMI programming standard document templates.
2. Review the SCADA / HMI configuration, the HMI system database, control schemes, displays, report formats, etc. with the ENGINEER and OWNER on at least 3 occasions during development:
 - a. Preliminary meeting: Before configuration work is begun. The ICSC must bring to this meeting example of displays, display symbols, reports, etc. to show the capabilities of the system software.
 - b. Intermediate review meeting: Held after the initial database is entered and typical screens and reports have been entered.
 - c. Pre-submittal review meeting: Submit an informal hardcopy of developed HMI screens for review by the ENGINEER to determine that requirements are being sufficiently met.
 - d. Final review meeting: Held after initial completion of all configuration work. This final meeting may not be held in conjunction with the Source Test. Make final format revisions after this review. All HMI screen development screens and methods shall be documented in County PLC and HMI programming standard document templates.

E. Source testing:

1. Before the delivery and installation of the PCS system to the job site, but after the procurement, assembly, and configuration of all components, perform the Source Test.
2. Before the delivery and installation of control panels, PLCs, control system equipment, and other PCS components at the job site, but after the procurement and assembly of components, perform Source Test.
3. Schedule the Source Test after receiving approval of the Source Test

- procedures submittal.
4. Submit a copy of the test procedures including all forms at least 21 days before any scheduled test date.
 5. Notify the ENGINEER of scheduled tests a minimum of 15 days before the date of the test.
- F. General Field Start-Up and testing procedures:
1. As specified in the Contract Documents.
- G. Installation testing:
1. As specified in the Contract Documents.
 2. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.
 3. Acceptance of the PCIS Installation testing must be provided in writing by the OWNER before the performance testing may begin.
- H. Training:
1. As specified in the Contract Documents.
- I. Functional testing:
1. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.
 2. Loop validation test.
 3. As specified in Section 40 80 00 - Commissioning for Instrumentation and Controls.
 - a. Notify the OWNER of scheduled tests a minimum of 21 days before the estimated completion date of installation and wiring of the PCIS.
 - b. Complete loop validation testing a minimum of 5 days before the pre- commissioning phase of the project.
 - c. Loop validation certifications:
 - 1) After the field device loop tests have been successfully completed as specified in Section 40 80 00 - Commissioning for Instrumentation and Controls for all individual instruments, all separate analog control networks, all valves, all VCPs, all motors, all local operator interface panels, all motor control centers, etc., submit a certified copy of all test forms signed by the Contractor, Vendor, and the OWNER's representative with test data entered, together with a clear and unequivocal statement that all instrumentation, including all control and signal wiring, has been successfully calibrated, inspected, and tested.
 - a) Acceptance of the PCIS Installation Testing must be provided in writing by the ENGINEER before the Process Operational Period may begin.
- J. Provide all special tools and spare parts, as specified in the Maintenance paragraph of this Section, before Process Operational Period commences, suitably wrapped, and identified.

K. Process Operational Period:

1. Upon completion of the Process Operational Period, conduct an Instrumentation and Controls Process Performance Test as a condition for Project final completion.

1.9 SCHEDULING (NOT USED)

1.10 WARRANTY

- A. Provide additional warranty as specified in the individual Instrumentation and Control Specifications that extends beyond the Correction Period, as specified in the Contract Documents.

1.11 SYSTEM PROCESS START-UP

- A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the ENGINEER.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE

- A. Before Substantial Completion, perform all maintenance activities required by the Contract Documents including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.
- B. Furnish all spare parts as required by the Contract Documents.
- C. Spare parts:
1. Furnish the spare parts selected by the OWNER or ENGINEER from the priced list of spare parts in the hardware submittal.
 2. Furnish a price list of all special tools required to calibrate and maintain all of the instrumentation provided under the Contract Documents. Furnish the special tools selected by the ENGINEER from the priced list.
- D. Provide additional spare parts specified in other sections of the Instrumentation and Control Specifications.
- E. Submit all special tools and spare parts, suitably wrapped and identified, before Process Operational Period commences.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Provide similar items from a single manufacturer throughout the PCIS portion of the Project for system standardization.
- B. Allowable manufacturers are specified in individual instrument and equipment specifications.

2.2 SYSTEM DESCRIPTION

- A. Scope:
 - 1. ICSC shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a complete and operating instrumentation and control system.
 - 2. The Scope of Work includes the following major tasks:
 - a. Furnish and install Pump Station Control Panel and panel-mounted instruments and devices.
 - b. Furnish and install Network Interface Panel and panel-mounted instruments and devices.
 - c. Furnish and install Mission RTU panel. Mission RTU panel shall be a vendor provided packaged system. Contractor shall employ services of the Mission RTU manufacturer services to configure the Mission RTU unit and the Mission Web Server for the required operations.
 - d. Provide all field instruments specified in Contract Documents, installation, commissioning, calibration, start up and field-testing services.
 - e. All Programming and configuration required on the PLC and OIT, for monitoring and control of the pump station. Complete monitoring and control of the pump station shall be available from the panel mounted OIT.
 - f. Configuration required on the network hardware provided under the Contract, for interconnectivity between the pump station and Bee Ridge WRF SCADA servers.
 - g. Remote monitoring and control of the pump station shall be made available from Bee Ridge WRF. New SCADA HMI screens for the pump station shall be developed in Aveva Systems Platform and added to the OWNER's existing SCADA infrastructure at Bee Ridge WRF. ICSC shall coordinate with OWNER to obtain samples of SCADA screen displays from existing server to coordinate similar look and feel for the new screen development. ICSC shall coordinate work required to access and interface with the existing servers located at Bee Ridge WRF to provide a fully operational system.
 - h. ICSC shall configure Diesel Engine Pump system's monitoring signals for SCADA HMI displays and WIN-911 alarming, through OWNER's existing network connection between Mission Web Server and SCADA system.
 - i. ICSC shall conduct workshops with the OWNER and ENGINEER to develop control logic and graphical screen development

requirements as detailed in Article 1.8.

B. General requirements:

1. The Work includes everything necessary for and incidental to executing and completing the instrumentation and control system work indicated on the Drawings and specified in the Specifications and reasonably inferable there from including but not limited to:
 - a. Preparing hardware submittals for field instrumentation.
 - b. Design, develop, and draft loop drawings, control panel designs, and all other drawing submittals specified in the Instrumentation and Control Specifications.
 - c. Prepare the test plan, the training plan, and the spare parts submittals.
 - d. Procure all hardware.
 - e. Provide all PCS system hardware.
 - f. Provide all PCS system software.
 - g. Fabricate panels.
 - h. Perform factory tests on panels.
 - i. Perform bench calibration and verify calibration after installation.
 - j. Oversee and certify installation of the PCS system.
 - k. Oversee, document, and certify loop testing.
 - l. Oversee, document, and certify system.
 - m. Installation Testing.
 - n. Oversee and document Functional Testing.
 - o. Conduct the Process Operational Period and the Instrumentation and Controls Process Performance Testing.
 - p. Prepare operation and maintenance manuals.
 - q. Conduct training classes.
 - r. Integrate the PCS with instrumentation and control devices provided under other sections.
 - s. Provide Record Drawings and Loop Drawings associated with Instruments and equipment:
 - 1) As specified in the Contract Documents.
 - 2) For OWNER furnished items (i.e.: OWNER furnished servers and network switches.)
 - 3) For interfaces with existing equipment.
 - t. Resolve signal, power, or functional incompatibilities between the PCS and interfacing devices.
 - u. Perform all required corrective and preventative maintenance.
2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of all equipment furnished by others, as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
3. Provide the complete operating PCS to perform the specified monitoring, communications, alarm, control, display, and reporting functions in accordance with the PCS requirements.

4. Coordinate all aspects of the Work between Contractor and all subcontractors before bidding to ensure that all costs associated with a complete installation are included. The OWNER is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the ICSC, the other subcontractors, or suppliers.
5. Furnish detailed, complete, and thorough operations and maintenance documentation, including but not limited to operations manuals, maintenance manuals, as-built wiring drawings, training manuals, as-built software documentation, and all other documentation required to operate, modify, and maintain all parts of the PCS.
6. Where demolition is indicated on the Drawings, the electrical subcontractor is responsible for disconnecting equipment electrical connections and rendering the equipment safe. The ICSC is responsible for physically removing all instrumentation to be demolished and return it either to the OWNER or dispose of it as directed by the OWNER's representative. The ICSC shall be responsible for any program modifications needed based on the demolition of the equipment, both for the loops directly and indirectly affected.
7. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment.
 - a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before performing any Work.
 - b. Provide and document interface with, modifications to, upgrade, or replacement of existing circuits, power systems, controls, and equipment.
8. Revise in a manner as directed by the ENGINEER all I/O and addressing that the ENGINEER determines to be unacceptable as a result of a lack of Contractor coordination between Contract Documents and all suppliers.

C. Operating facility:

1. Existing facilities must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines where work is done on existing facilities:
 - a. All outages must be of minimal duration and fully coordinated and agreed too by the Owner. Adjust the construction to meet the requirements of the Owner.
 - b. As weather and facility demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.
 - c. Where portions of the Work are in existing facilities and require interface to existing circuits, power systems, controls, and equipment, perform comprehensive and detailed field investigations of existing conditions. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls and equipment.
2. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.

3. Where shown or specified, replace existing field instruments with new.
4. Contractor is responsible for the integrity and measurement accuracy of all loops.
5. The standards of documentation, instrument tagging, cable and conductor termination, terminal identification and labeling that apply to the new installation apply equally to the existing installation.

2.3 MATERIALS

- A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these devices and that bear all approvals and labels as required by the Specifications.
- B. Provide materials complying with the applicable industrial standard as specified in the Contract Documents.

2.4 COMPONENTS

- A. Furnish all meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise specified to match existing equipment.
- B. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of within 0.5 percent of full scale and a minimum repeatability of within 0.25 percent of full scale.
- C. Signal transmission:
 1. Analog signals:
 - a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable, unless otherwise indicated.
 - b. Furnish electrical analog signals outside control panels that are 4-to-20 milliamperes 24 VDC, except as indicated.
 - c. Electrically or optically isolate all analog signals from other signals.
 - d. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
 - e. Maintain the total 4-to-20 milliamperes loop impedance to 10 percent below the published value at the loop operating voltage.
 - f. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
 2. Pneumatic signals:
 - a. All pneumatic signals: 3-to-15 pounds per square inch gauge.
 3. Discrete input signals:
 - a. As indicated in the controller hardware specification.
 4. Discrete output signals:
 - a. Dry contacts or TRIAC outputs (with express written approval by the ENGINEER) as needed to coordinate with the field device.

- b. Provide external terminal block mounted fuse with blown fuse indication for all discrete outputs.
 - c. Provide interposing relays for all discrete outputs for voltage and/or current compatibilities.
 - d. Provide interposing relays as required for functionality of the control circuit.
- 5. Signal performance and design criteria:
 - a. Stability:
 - 1) After Controls have taken corrective action, oscillation of the final control element shall not exceed 2 cycles per minute or a magnitude of motion of 0.5 percent of full travel.
 - b. Response:
 - 1) Any change in setpoint or controlled variable shall produce a corrective change in position of the final control element and stabilized within 30 seconds.
 - c. Agreement:
 - 1) Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
 - d. Repeatability:
 - 1) For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position the final element.
 - e. Sensitivity:
 - 1) Controls shall respond to a setpoint deviations and measured variable deviations within 1.0 percent of full scale.
 - f. Performance:
 - 1) All instruments and control devices shall perform in accordance with the manufacturers' specifications.
- D. Discrete circuit configuration:
 - 1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
 - 2. Alarm contacts: Fail to the alarm condition.
 - 3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.
- E. Grounding:
 - 1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
 - 2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable.
 - 3. Insulate the shielding and exposed drain wire for each signal cable with heat- shrink tubing.
 - 4. Terminate the signal cable shield on a dedicated grounding terminal block.
 - 5. Provide isolating amplifiers within control panels for field equipment

possessing a grounded input or output, except when the panel circuit is galvanically isolated.

F. Instrument air:

1. Where indicated on the Drawings, provide dry, filtered control air at 30 pounds per square inch gauge nominal pressure piped to all field instruments and instrument panels requiring air:
 - a. Provide each field instrument with an integral, non-adjustable filter/regulator assembly to provide regulated air.
 - b. Provide each instrument panel requiring air with an adjustable filter/regulator assembly with gauge and an air manifold to provide air to pneumatic instruments.
 - c. Filter all air to 5-micron maximum particle size.
 - d. Provide low pressure switch to alarm on insufficient air supply.

2.5 ACCESSORIES

A. Provide flow conditioning devices or other required accessories if necessary, to meet the accuracy requirements in the Contract Documents.

B. Nameplates:

1. Provide a nameplate for each controller, instrument transducer, instrument power supply, solenoid, or any other control device located either in the field or within panels.
2. All nameplates shall be of identical style, color, and material throughout the facility.
3. Device nameplates shall include:
 - a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
 - 1) Device tag and loop number ID (e.g., FIT-60.011).
 - 2) PLC ID (e.g., PLC-11).
 - 3) Power information (e.g., PCM-11, 120VAC).
 - b. White lettering on a black background, laminated plastic.
4. All instruments shall be equipped with Type 316 stainless steel nameplate with the instrument tag stamped in 3/8-inch letters and connected to the instrument using Type 316 stainless steel wire.

2.6 SOURCE QUALITY CONTROL

A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the Specifications.

B. Arrange with all manufacturers of the equipment and fabricators of panels and cabinets, to allow the OWNER and ENGINEER to inspect and witness the testing of the equipment at the site of fabrication:

1. Equipment includes the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices.

- C. Source Test is specified in Section 40 80 00 - Commissioning for Instrumentation and Controls.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. The ICSC is encouraged to attend a pre-bid conference and examine the premises completely before bidding. It is the ICSC's responsibility to be fully familiar with the existing conditions and local requirements and regulations.
- B. Review the existing Site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.
- C. Provide a complete instrumentation and control system:
 - 1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, and process control and instrumentation system.

3.2 INSTALLATION

- A. Equipment locations indicated on the Drawings may change due to variations in equipment size or minor changes made by others during construction:
 - 1. Verify all dimensions as indicated on the Drawings:
 - a. Actual field conditions govern all final installed locations, distances, and levels.
 - 2. Review all information indicated on the Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical, instrumentation, and mechanical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
 - 3. Make minor changes in location of equipment before rough in, as directed by the OWNER or ENGINEER.
- B. Perform all related Electrical Work in accordance with the applicable sections of the Electrical Specifications.
- C. The PCIS configurations are diagrammatic:
 - 1. The locations of equipment are approximate unless dimensioned.
 - 2. Where Project conditions require, make reasonable changes in locations and arrangements.
- D. Field instruments installation:
 - 1. Install field instruments as specified in the Contract Documents, API RP 550 and RP 551, and the manufacturer's instructions.
 - 2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
 - a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.

- b. Provide sun shields for all field electronic instruments located outdoors.
 - 3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
 - a. Type of flexible conduit required for the area classification:
 - 1) Area classification as specified in Section 26 05 05 – General Provisions for Electrical Systems.
 - b. Maximum length of 18 inches.
 - 4. Connect field instruments with cable as specified in the Electrical Specifications, except when the manufacturer requires the use of special cable, or otherwise specified in this Section:
 - a. Special cable applications shall be in accordance with the NEC.
 - 5. Verify the correctness of each installation:
 - a. Polarity of electric power and signal connections.
 - 6. Ensure all process connections are free of leaks.
 - 7. Provide a power disconnect switch for each 120 VAC powered instrument which does not have a built-in power disconnect:
 - a. Disconnect enclosure suitable for the area classification:
 - 1) As specified in Section 26 05 05 – General Provisions for Electrical Systems.
- E. Process sensing lines and air tubing:
 - 1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
 - 2. Provide supports for rigid tubing at intervals of not more than 3 feet.
 - 3. Slope horizontal runs of instrument tubing at a minimum of 1/16-inch per foot to allow for draining of any condensate.
 - 4. Bends:
 - a. Make bends for parallel lines symmetrical.
 - b. Make bends without deforming or thinning the walls of the tubing.
 - 5. Square-cut and clean all ends of tubing before being inserted in the fittings.
 - 6. Provide bulkhead fittings at all panels requiring pipe and/or tubing entries.
 - 7. Use stainless steel tubing for all piping hard piped from the air header, unless otherwise indicated on the Drawings or not compatible with the fluids or atmosphere in the area:
 - a. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times maximum travel of the equipment.
- F. Equipment tie-downs:
 - 1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the Site.
 - 2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., shall be permanently mounted and tied down to structures.

G. Existing instrumentation:

1. Clean, recondition and re-calibrate each existing instrument to be reused, removed, or reinstalled using an authorized service facility of the instrument manufacturer.
 2. Provide certification of this Work before reinstallation of each instrument.
- H. Instrument tagging:
1. As specified in Section 26 05 53 - Identification for Electrical Systems.
 2. Provide all field-mounted instruments with nameplates:
 - a. Nameplates engraved with the instrument's full tag number as indicated on the Drawings:
 - 1) Affix tags with stainless steel wire fasteners.
 3. Provide all back of panel instruments with nameplates:
 - a. Engraved with the instrument's full tag number as indicated on the Drawings:
 4. Provide all front of panel instruments with a nameplate:
 - a. Engraving to include the following:
 - 1) Instrument's full tag number.
 - 2) Service description.
 - b. Nameplates:
 - 1) Secure nameplates to the panel with stainless steel screws.
 - 2) Use an accepted adhesive if screws would violate the NEMA or other ratings of the enclosure.
- I. Cable and conductor termination:
1. Terminate all cables and conductors on terminal blocks.
 2. Terminal block enclosures:
 - a. Suitable for the area classification as specified in Section 26 05 05 - General Provisions for Electrical Systems.
- J. Surge protection:
1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments and in the control panel.
 2. Individually fuse each 4 to 20 milliamperes direct current loops with a 1/2- ampere fuse between power supplies and receiver surge protectors.
 3. Provide voltage surge protection for 4 wire transmitters and analyzers:
 - a. Protect both power source and signal loop.

3.3 COMMISSIONING

- A. As specified in –the Contract Documents.
- B. OWNER Training:
1. Demonstration requirements are specified in Section 40 80 00 - Commissioning for Instrumentation and Controls.
 2. General:
 - a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.
 - b. Provide system maintenance and operator training courses for all the instrumentation and control equipment and systems furnished, as described below.

- 1) All training described below shall be provided by the Contractor.
- c. Conduct all training at the Project Site unless another location is accepted by the ENGINEER and OWNER:
 - 1) Include instruction on the use of all maintenance equipment and special tools provided under the Contract.
 - 2) Tailor training classes to the specific needs of the class participants:
 - 3) Develop separate courses for operators, maintenance staff, and supervisors:
 - a) The specific categories and number of personnel in each category are identified below.
 - 4) Furnish training courses that are a combination of classroom and hands-on training:
 - a) To the greatest extent possible, utilize components from the OWNER's PCS system.
 - b) Limit classes that include extensive hands-on activities to a maximum of 5 students per class.
 - 5) Present the minimum number of sessions, specified in Section 40 80 00 Commissioning for Instrumentation and Controls, for each course in order to satisfy class size restrictions and limitations scheduling OWNER staff.
 - 6) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.
- d. Schedule individual training classes:
 - 1) Coordinate with the OWNER at least 3 weeks before the start of the class:
 - 2) Schedule training classes Monday - Friday between 7:30 a.m. and 3:30 p.m.
 - 3) Each individual daily training session, travel time excluded:
 - a) Minimum duration of 4 hours.
 - b) Maximum duration of 7 hours.
 - c) Breaks scheduled at least every 90 minutes and 1 hour for lunch.
 - 4) Complete training for maintenance personnel 90 days before Process Operational Period.
 - 5) Complete operator training classes before process start-up of the control system software, or any part of it:
 - a) As specified in the Sequencing article of this Section.
 - 6) Schedule follow-up training classes after the PCS start-up on a schedule determined by the OWNER.
- e. Instructor qualifications:
 - 1) Highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:
 - a) Instructor qualifications are subject to the approval of the ENGINEER.
 - 2) Furnish training instructors thoroughly familiar with the PCIS system, who are members of the implementation team.
 - 3) One of the individuals conducting the PCIS training course must

be the same individual responsible for the majority of the programming that was performed for the instrumentation and control system.

3. Training manuals and materials:
 - a. Furnish training manuals and other materials for training courses.
 - b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.
 - c. The manuals are to serve as teaching aids during presentation of the training classes.
 - d. Manuals are to serve as reference material after the training has been completed.

3.4 FIELD QUALITY CONTROL

- A. Inspection:
 1. Allow for inspection of PCIS installation as specified in the Contract Documents.
 2. Provide any assistance necessary to support inspection activities.
 3. ENGINEER inspections may include, but are not limited to, the following:
 - a. Inspect equipment and materials for physical damage.
 - b. Inspect installation for compliance with Drawings and Specifications.
 - c. Inspect installation for obstructions and adequate clearances around equipment.
 - d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.

+ + END OF SECTION + +

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Submittal requirements.
 - 2. General programming requirements.
 - 3. Common control functions:
 - a. General control and monitoring functions to be provided throughout the PCS system. These requirements apply to all systems and supplement the specific loop descriptions and information indicated on the Drawings.
 - 4. Process Control Strategies.
- B. ICSC shall coordinate with OWNER to obtain PLC Design Standards and SCADA Design standards prior to programming of the PLCs and SCADA software.
- C. ICSC shall regularly conduct workshops as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems, to coordinate PLC logic and graphics development and establish design standards.

1.2 REFERENCES

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.
- B. Hardwired control: Control circuitry that does not utilize software to initiate functionality.
- C. Hardwired interlocks: A safety or protective feature that will interrupt operation of the equipment in all operating modes with no required operator intervention.
- D. Software interlocks: A safety or protective feature that will interrupt operation of the equipment when the PLC has control.
- E. Slew rate: Rate of change in respect to time.
- F. Clamp: Imposed upper and lower limits on setpoints to eliminate entries outside the allowable control parameters.
- G. Watchdog timer: Timers imposed to test components such as discrete I/O

to verify the health of the card.

1.4 SYSTEM DESCRIPTION

- A. This section outlines control and programming standards for use in the project. This section is supplemented by project specific control strategies to be implemented on this project. Control logic, function blocks, graphical objects, templates, and program organization shall be followed from the PLC and SCADA standards to the greatest extent possible for overall system standardization. Obtain existing code libraries and objects from the OWNER prior to starting any work.
- B. Project specific control strategies are to be implemented using existing logic to the greatest degree possible and reuse control strategies for similar systems at other Owner facilities. Obtain examples of similar systems during software workshops.
- C. PLC design standards are provided which document existing PLC programming, standards, and implementation guidelines. Where sections are not completed but needed during a specific project, they shall be coordinated, and standards developed as part of the software workshops and project implementation and testing. The final agreed upon methods and standards shall be documented in this manual as part of the project.
- D. SCADA design standards are provided which document existing SCADA software requirements, graphical screens, graphical standards, and implementation guidelines. Where sections are not completed but needed during a specific project, they shall be coordinated, and standards developed as part of the software workshops and project implementation and testing. The final agreed upon methods and standards shall be documented in this manual as part of the project.

1.5 SUBMITTALS

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.
- B. All PLC logic and HMI graphic screens must be submitted for review prior to implementation on any system. Any PLC logic or HMI conventions developed that do not meet existing standards will be rejected and require redevelopment.

1.6 WARRANTY

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.
- B. After the bid has been awarded, the ICSC shall submit an RFI for the OWNER standard graphics and PLC objects library.
- C. General programming requirements:
 - 1. Use variable names or aliases derived from tag and loop identification on the P&IDs for all process values.
 - a. Submit names for Owner approval.
 - b. Unless otherwise noted, utilize floating-point format for all PLC algorithms and calculations.
 - c. Provide PLC logic to convert raw input values into engineering units in a floating-point format.
 - 2. Store all adjustable parameters in the PLC and configure so that an operator with sufficient security access can change the parameters from the LOI or HMI. Update and display the current value at all locations, regardless of where the last change was made.
 - 3. Reusable PLC code blocks:
 - a. OWNER will provide standard user defined function blocks (UDFBs) and user-defined types (UDTs) for PLC programming. Utilize these standards wherever possible in PLC programming.
 - b. Develop and use new standard user defined function blocks (UDFBs) and user defined types (UDTs) where appropriate and obtain approval from OWNER before use. One instance of each standard code block shall reside in each PLC and shall be referenced in main routines and subroutines.
 - c. New code blocks that the Contractor would like to use as a standard shall be submitted to OWNER for review and approval.
 - d. Provide complete library of standard code blocks to OWNER as part of O&M documentation.
 - e. Each new code block must be documented as shown in the example in the PLC Design Standards document and added to this document.
 - 4. Documentation:
 - a. All control logic shall be completely annotated including all rungs, instructions, and tags.
 - b. Each routine shall have a title and a detailed description of the control strategy represented by the control logic. Where parameters are passed to the routine, all parameters shall be defined in the routine description.
 - c. Analog tag descriptions representing process variables shall include the engineering unit range of the analog variable.
 - d. Digital tag descriptions shall include the On and Off state labels.
 - e. Complete, grammatically correct sentences and terminology, consistent with water treatment processes, shall be utilized in the development of rung and routine descriptions.
 - f. All equations developed in the process logic shall be fully documented in the rung or routine description. A description of each constant and variable utilized in the equation shall be defined including engineering units.
 - 5. Program slew rates for setpoints to limit the effect of updated setpoints

on the process:

- a. Provide for control setpoints and manual speed and position selections.
- b. Store new setpoints in one register, and gradually ramp the actual setpoint register at the slew rate until it reaches the new value.
- c. Provide operator access to change slew rates from the HMI.
6. Saved setpoints:
 - a. Provide an operator selection to save all setpoint values.
 - b. Furnish 1 or more screens at the HMI that display the initial values for all setpoints defined during start-up and the value for each setpoint the last time they were saved.
 - c. Where possible use a DFB or AOI to provide an operator selection to restore all setpoints to the initial start-up value.
 - d. Provide an operator selection to restore all setpoints to the last saved value.
7. Nuisance alarm suppression:
 - a. Provide nuisance alarm suppression to prevent alarm floods caused by failure conditions such as power fail or communication loss or major equipment item failures.
 - b. Adjust alarm delays and resets as required to prevent alarm floods.
 - c. Implement nuisance alarm suppression in all standard blocks.
8. Store a copy of all adjustable parameters and accumulated and integrated totals in PCS:
 - a. Upon re-loading of the PLC program, re-load these values to the PLC from PCS or processor memory card.
 - b. PLCs provide a minimum 2 week data storage to provide for data accumulation and later communication to the Historian in the event of a network interruption.
9. Calculated values:
 - a. Program calculations such that division by zero errors cannot occur.
 - b. Prevent calculations from generating values that exceed the limits of the equipment or data type structures (integers) internal to the PLC.
 - c. Configure counting functions (start counts and operation counts) to allow a minimum of 10,000 counts, and to roll-over to zero at an even decimal interval (1 followed by 4 or more zeros).
 - d. Configure integrating functions to accurately accumulate the maximum rate from the instrument/equipment (totalizers, run time meters) for a minimum of 30 years. Utilize manufacturer AOI/DFBs etc. where possible.
10. Timers:
 - a. Provide programmable settling and proving timers in control sequences as required for starting and stopping of equipment to allow the process to settle down before proceeding with any additional control functions.
 - 1) The settling timers may be overridden by setting the timer to 0 seconds.
11. Control Panel status:
 - a. Design the PLC system to function as a stand-alone unit that performs all of the control functions described in this Section completely independent from the functions of the PCS system PC-based operator

interfaces:

- 1) Failure of the PCS system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
- b. Furnish a minimum of 1 screen that depicts the status of all enclosures containing PLCs, communication equipment, UPS or I/O in the control system, including but not limited to the following:
 - 1) PLC cabinet over-temperatures from high temperature switch.
 - 2) Intrusion status on all enclosures equipped with intrusion switches.
 - 3) AC power failure:
 - a) Monitor ahead of UPS.
 - 4) DC power supply failure:
 - a) For redundant power supplies, alarm when either power supply or the diode bridge fails.
 - 5) UPS failure signal.
 - 6) UPS Low Battery signal.
 - 7) Digital bus network Coupler and or Gateway failure signal.
 - 8) Ethernet Switch failure signal.
12. PLC system communication status:
 - a. Furnish a minimum of 1 screen to display all communication errors and status within the PCS:
 - 1) Communication between PCS and PLCs, PLC to PLC, PLC to RIO and PLC and or PCS to VCP.
 - 2) 4-20 mA HART interface cards.
 - 3) Digital bus network status:
 - a) DeviceNet and ControlNet scanners.
 - 4) Modbus Gateway modules.
 - 5) Display status of each node, and summary of failures over the past 60 minutes.
 - b. Generate a communications alarm if any communication fault is detected or there is no response from a node for more than a user specified time.
 - c. In the event of communications loss:
 - 1) Continue normal operation at each PLC.
 - 2) Where control parameters are received over a communications link:
 - a) If a link fails where process elements use the remote value for closed-loop control, hold operating status, speed and position, of the process elements at their last state before the communication alarm, unless other I/O local to that PLC indicates shutdown or over-ride conditions:
 - (1) Ensure that the operator can control the process using PCI\S HAND mode at the local LOI.
 - b) If a link fails where process elements use the remote value to determine setpoints, continue to operate using the last value received:
 - (1) Provide a manual over-ride entry at the local LOI to allow an operator to enter a different value for any such remote signal.

- (2) Generate an alarm whenever an over-ride value is in use.
- 13. 4-20 mA Hart interface cards:
 - a. Provide the following HART protocol information for each populated channel on the card:
 - 1) Process variable values:
 - a) Primary process variable (analog): 4-20 mA current signal.
 - b) Primary process variable (digital): Digital value in engineering units.
 - c) Percent range: Primary process variable expressed as percent of calibrated range.
 - d) Loop current: Loop current value in milliamps.
 - e) Secondary process Variable 1: Digital value in engineering units available from multivariable devices (if applicable).
 - 2) Host commands:
 - a) Set primary variable units.
 - b) Set upper range.
 - c) Set lower range.
 - d) Set damping value.
 - e) Set message.
 - f) Set tag.
 - g) Set date.
 - h) Set descriptor.
 - i) Perform loop test: Force loop current to specific value.
 - j) Initiate self-test: Start device self-test.
 - k) Get more status available information.
 - 3) Status and diagnostic alerts:
 - a) Device malfunction: Indicated device self-diagnostic has detected a problem in device operation.
 - b) Configuration changed: Indicates device configuration has been changed.
 - c) Cold start: Indicates device has gone through power cycle.
 - d) More status available: Indicates additional devices status data available.
 - e) Primary variable analog output fixed: Indicates device in fixed current mode.
 - f) Primary variable analog output saturated: Indicates 4-20 mA signal is saturated.
 - g) Secondary variable out of limits: Indicates secondary variable value outside the sensor limits.
 - h) Primary variable out of limits: Indicates primary variable value outside the sensor limits.
 - 4) Device identification:
 - a) Instrument tag: User defined, up to 8 characters.
 - b) Descriptor: User defined, up to 16 characters.
 - c) Manufacturer name (code): Code established by HCF and set by manufacturer.
 - d) Device type and revision: Set by manufacturer.
 - e) Device serial number: Set by manufacturer.

- f) Sensor serial number: Set by manufacturer.
- 5) Calibration information:
 - a) Date: Date of last calibration, set by user.
 - b) Upper range value: Primary variable value in engineering units for 20 mA point, set by user.
 - c) Lower range value: Primary variable value in engineering units for 4 mA point, set by user.
 - d) Upper sensor limit: Set by manufacturer.
 - e) Lower sensor limit: Set by manufacturer.
 - f) Sensor minimum span: Set by manufacturer.
 - g) PV damping: Primary process variable damping factor, set by user.
 - h) Message: Scratch pad message area (32 characters), set by user.
 - i) Loop current transfer function: Relationship between primary variable digital value and 4-20 mA current signal.
 - j) Loop current alarm action: Loop current action on device failure (upscale/downscale).
 - k) Write protect status: Device write-protect indicator.

D. Common control functions:

1. Incorporate common control functions into all control loops and devices and into the control programming, whether or not specifically shown in the specific control descriptions or elsewhere in the Contract Documents.
2. Alarms:
 - a. Generate alarms within the PLC logic.
 - b. Indicate alarms at the LOI and HMI. Enable acknowledgement from either the HMI or the LOI.
 - c. Generate high, high-high, low, and low-low level alarms where indicated:
 - 1) Provide an alarm reset deadband for each analog value to prevent excessive repeated alarms.
 - 2) Provide logic and timers to inhibit analog alarms based on process events. For example, inhibit low flow alarms when a pump is stopped, or has not been running long enough to establish flow.
 - d. Flash all alarm and fail conditions and their respective indicators on the PCS graphic screens and local indicating lights until the condition is acknowledged by the operator, even if the alarm condition is no longer present.
 - e. Once the alarm is acknowledged by an operator, display alarm conditions in a steady state (not flashing) while the alarm condition is still present:
 - 1) Flash with a cycle rate of 1/2 second on and 1/2 second off.
 - f. Once the alarm has been cleared and the operator has acknowledged the alarm or fail condition, turn the graphic alarm indicator off.
 - g. For all alarms that do not have inherent timers, provide an operator-adjustable proving timer to limit nuisance alarms, continuously adjustable from zero seconds to 100 minutes. The initial setting of proving timers shall be zero seconds:

- 1) The PLC shall start the timer when it first detects an alarm condition and shall only activate the alarm after the timer has expired.
- 2) If the alarm condition clears while the timer is running, the timer shall reset, and the alarm shall not be activated.
- h. Use interlocks and proving timers to prevent alarms from operating due to power loss, except for loss of power alarms.
- i. Furnish an alarm silence pushbutton at each PCM, LOI, or LCP with an audible alarm to signal the PLC to turn off the audible alarm until the next alarm occurs.
- j. Call Out alarms that are not acknowledged after a setpoint period of time shall activate the auto dialer.
- k. Lamp test: Furnish lamp test pushbuttons at each control panel with more than 10 pilot lights, that illuminates all pilot lights on the panel:
 - 1) The lamp test may sequence through blocks of lights.
 - 2) Minimum on time for each lamp during lamp test 15 seconds.
- l. Horns and Beacons:
 - 1) Activate PCM horn and beacon on all critical alarms and on other alarms as defined by the Facility Alarm Philosophy.
 - 2) Deactivate PCM horn and beacon when PCM reset pushbutton is activated.
 - 3) Silence PCM horn when PCM silence pushbutton is activated.
- m. Dual analog instruments:
 - 1) For applications where 2 or more analog instruments are measuring the same process variable:
 - a) Generate an operator adjustable percent deviation alarm.
 - b) Allow operator to take each instrument out of service when an instrument is out of service.
3. Where a reset is shown for counts, totals and times maintained in the PLC:
 - a. Provide a reset selection on the HMI screen that displays the value.
 - b. Provide a preset function on the HMI to allow an operator-entered value to become the current accumulated total.
 - c. Limit access to the reset and preset functions to operators with suitable security level.
 - d. Log the value before reset, operator, time, and date of reset in the PCS archive.
 - e. Log the value before preset, preset value, operator, time, and date of preset in the PCS archive.
4. Where start counts are indicated on the Drawings, or required in this Section, count starts for each piece of equipment (off to on transitions of running status) in the PLC:
 - a. Display total starts on PCS screens and provide a reset function.
 - b. Where indicated, calculate number of starts for each day:
 - 1) Display current day and previous day starts on PCS displays.
 - 2) Do not reset daily start count when overall count is reset.
 - 3) Archive starts for each day through PCS.
5. Where run time accumulation is indicated on the Drawings, or required in this Section, integrate accumulated run time to the nearest 0.1 hour whenever the running status input indicates that the equipment is running:
 - a. Display total run time in hours on PCS screens.

- b. Where indicated, calculate total run time for each day:
 - 1) Display current day and previous day run time on the HMI to the nearest 0.1 hour.
 - 2) Do not reset daily run time when overall time is reset.
 - 3) Archive run time for each day through PCS.
 - 6. For all monitored analog values:
 - a. Convert all values to engineering units in floating-point format within the PLC.
 - b. Maintain trends in PCS.
 - 1) Display minima and maxima on the HMI, and archive through PCS.
 - c. Flows and Weights:
 - 1) Totalize flows in the PLC logic:
 - 2) Where totalized flows are input to a discrete input, count input pulses and multiply by the volume per pulse.
 - 3) Where no totalizer input is shown, integrate the analog input over time.
 - 4) Display totals on the HMI and LOI.
 - 5) Archive totals to the historical database through PCS.
 - d. Generate an alarm whenever an over-ride value is in use.
 - e. Calculate hourly, daily, and monthly averages:
 - 1) Calculations shall be performed by the PLC.
 - 2) Display averages on the HMI, and archive through PCS.
 - 3) Display minima and maxima on the HMI, and archive through PCS.
 - f. Calculate minimum and maximum values each day, and month:
 - 1) Calculations may be performed by the PLC or PCS.
 - 2) Display minima and maxima on the HMI, and archive through PCS.
 - g. Generate an alarm whenever an over-ride value is in use.
 - 7. Analog data processing:
 - a. Engineering unit's conversion:
 - 1) Use engineering units for all analog point values. Convert analog inputs to engineering units.
 - b. Analog magnitude checking:
 - 1) Provide upper and lower limits to prevent operator-entered values (setpoints, etc.) from falling outside acceptable limits.
 - c. Analog value quality:
 - 1) Monitor analog values received at each PLC from analog inputs or communications from another PLC or RIO specific to critical analog values, and generate alarms for the following conditions:
 - a) Rate of change in excess of acceptable limit:
 - (1) Provide a separate rate limit for each value.
 - b) Stale value:
 - (1) For analog signals that come from analog inputs or calculations using analog inputs, which are expected to have some variation each time the input is read, alarm when there is no change in the value for 10 times the normal expected scan or communication update.

8. Tank and vessel levels:
 - a. Display all tank and vessel levels as both a level (typically in feet) and a volume (typically in gallons):
 - 1) Some individual displays may be only level or volume, when agreed to by the OWNER and ENGINEER during screen meetings.
 - b. Monitor rate of change of volume on all tanks and vessels:
 - 1) Establish the maximum withdraw rate at which the volume should decrease (all pumps or feeders operating at maximum output). Generate an alarm whenever the volume decreases faster than this rate.
 - 2) Establish the minimum fill rate at which the volume should increase when filling. Generate an alarm whenever the volume increases faster than this rate. Verify tank and vessel level is fluctuating to verify the validity of the IO register. If it is determined the register is not active or failed in a manner that leaves a stagnant value generate an alarm.
9. I/O filtering and processing:
 - a. Analog input filtering:
 - 1) For each analog input provide an adjustable first order filter, for the purpose of smoothing out spikes and other noise for analog transmitter input signals. By default, configure analog inputs with no filtering affect.
 - 2) Monitor analog input signal quality:
 - a) Over range: The input value is above the normal range (typically over 21 mA).
 - b) Under range: The input value is below the normal range (typically under 3 mA, indicating a probable broken connection).
 - c) Generate alarms for over or under range inputs.
 - d) Do not use over or under range values for control or calculation purposes:
 - (1) Where a second instrument is provided to monitor the same condition (a redundant instrument, or additional instruments furnished for averaging or different operating modes), and has a valid signal, use that input for control.
 - (2) Otherwise, hold all outputs affected by the signal at their last values before the signal went out of range.
 - 3) Digital input filtering (proving timer):
 - a) Provide an adjustable time delay function (0-10 seconds) on discrete input for the purpose of de-bouncing.
 - b) By default, discrete inputs shall be configured with de-bounce timers set to zero seconds.
 10. Instrument scaling (HMI/LOI):
 - a. Provide 1 or more maintenance screens to display ranges and trigger points for all field instruments:
 - 1) For analog instruments, use input scaling values in the PLC to determine minimum and maximum calibration points.
 11. PCS HAND-OFF-AUTO:
 - a. Where indicated, provide HAND-OFF-AUTO and START-STOP

selections in the PCS, accessed from an LOI or HMI for operators with sufficient security, to provide the following operating modes:

- 1) PCS AUTO: The normal, automatic control mode of the strategy which allows full PLC control in response to process conditions and programmed sequences.
 - 2) PCS HAND: Enables PCS Manual control where control decisions are made by an operator through the PCS START-STOP, OPEN/CLOSE, or other selections as indicated.
 - 3) PCS OFF: Automated PCS control is disabled and PLC calls for all associated equipment to stop and valves to close or go to their identified safe state.
 - 4) Program the PLC so that switching a strategy between AUTO and HAND (either direction) occurs with a smooth transition. Keep running or position status unchanged when control is switched to HAND until a change is requested using the operator selections (START, STOP, OPEN, CLOSE). Keep running and position status unchanged when control is switched to AUTO until the control logic determines a change is required.
12. Display the current status of all operator selections (PCS HAND/AUTO, PCS START/STOP, etc.) on LOI and HMI.
 13. Interlocks:
 - a. Implement software interlocks where indicated to place equipment in a safe condition in response to impending hazardous process conditions. Apply software interlocks when equipment is operating in PCS AUTO or PCS HAND:
 14. Permissives:
 - a. Implement software permissives where indicated to prevent equipment from starting in an unsafe condition.
 - b. Apply software permissives when equipment is operating in PCS AUTO or PCS HAND.
 15. Process control algorithms:
 - a. Jog and hold: Unless otherwise indicated, use jog and hold control algorithms where possible:
 - 1) When the error between process variable and setpoint is beyond a setpoint deadband:
 - a) Jog valve or ramp speed in the required direction for a preset "Jog Time" or until the process variable reaches or passes the setpoint.
 - b) Then hold speed or position through a setpoint "Hold Time."
 - c) Continue alternating jog and hold until the error is less than the deadband.
 - 2) Provide operator access to Jog Time and Hold Time setpoints from the HMI.
 - b. PID algorithms: Use where indicated, or where necessary to provide fast response:
 - 1) Provide a PID faceplate with the following displays and functions for each PID control algorithm:
 - a) Display Output, CV.
 - b) Display Setpoint, SP.
 - c) Display Process Variable, PV.
 - d) Allow for operator selection of Automatic or Manual control

- of the output.
 - e) Under Manual control of output allow the operator to enter the desired output value.
 - f) Allow for input of the 3 Proportional, Integral, and Derivative tuning parameters.
 - g) Configure PID loops to prevent reset windup when controlled equipment is operating in Manual (local or PCS), or when the equipment has reached a physical limit.
 - h) When controlled equipment is being operated in remote PCS HAND, configure the PID function to track the process variable to provide a smooth transfer between Manual and Automatic modes.
 - i) Provide selectable slew rates with adjustable setpoints to allow the PID algorithm to slowly ramp to its final value to minimize system disturbance.
16. Equipment alternating and sequencing:
- a. Distribute number of starts and run time equally between identical equipment.
17. Motor control:
- a. Monitor the device's LOCAL-OFF-REMOTE (LOR) switch (the hard-wired switch at the MCC, drive or equipment) to determine when the PLC has control of the associated equipment:
 - 1) Display current REMOTE status on the PCS screens.
 - b. Monitor the device's running status from the starter auxiliary or run status input:
 - 1) Display the current status (running or stopped) on the PCS screens.
 - 2) Use status to calculate total run time and daily run time, and to count total starts and daily starts.
 - 3) Provide time stamp for each start.
 - 4) For motors 200 HP and greater, provide software to prevent exceeding the manufacturer's recommended maximum starts per hour.
 - c. When equipment control has been given to the PLC as reported by the LOCAL-OFF-REMOTE switch, allow selection of PCS AUTO or PCS HAND control modes based upon operator selection using the PCS screens.
 - d. Starting, stopping and running when the device LOR is in LOCAL:
 - 1) With the LOR switch in the LOCAL position, the motor is controlled by the START and STOP pushbuttons.
 - 2) With the LOR switch in the OFF position, the motor is prohibited from running.
 - 3) With the LOR switch in the REMOTE position, the motor is controlled remotely.
 - e. Starting, stopping and running when the device LOR is in REMOTE:
 - 1) When the motor is expected to be running (PLC has issued a START or RUN due to process conditions or operator selection), LOR is in REMOTE, and the device is not reported to be running, start an operator adjustable "Control Activation" timer:
 - a) Provide "Control Activation" timers for each piece of controlled equipment:

- (1) If the LOR and required running status do not change, and the PLC does not receive running status within the "Control Activation" time period:
 - (a) De-activate the output.
 - (b) Place the device in a "Failed" state.
 - (c) Generate a "Failed to Respond" alarm.
 - 2) When the motor is not expected to be running (PLC has issued a STOP or removed the RUN output), LOR is in REMOTE, and the device is reported to be running, start the "Control Activation" timer:
 - a) If the LOR and required stopped status do not change, and the PLC does not lose the running status within the "Control Activation" time period:
 - (1) Keep the RUN output off or the STOP output on.
 - (2) Place the device in a "Failed" state.
 - (3) Generate a "Failed to Respond" alarm.
 - 3) Re-establish PLC control of a device in a "Failed" state only after the following:
 - a) An operator turns the device's LOR switch out of REMOTE, and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).
 - f. Where motor winding high temperature switches or RTD temperature elements are shown, generate an alarm when high temperature is sensed (contact opens or temperature above the high alarm setpoint), but do not stop the motor unless otherwise indicated.
 - g. Motor equipped with current detection shall shut down and report a "failed" status on detection of high current.
 - h. Control two-speed motors similar to other motors, except as listed below:
 - 1) Motor states are RUN-FAST, RUN-SLOW, and STOP.
 - 2) Start all two-speed motors in the RUN-SLOW state. If or when the high speed is required (RUN-FAST operator selection or process conditions), transition to RUN-FAST after a designated time.
 - 3) When transitioning from RUN-FAST to RUN-SLOW, remove the RUN-FAST output or issue a STOP, then wait for a "Fast to Slow" time delay before energizing the RUN-SLOW or START-SLOW output.
 - i. Simultaneous starts:
 - 1) Prevent more than one motor-driven load 25 HP or larger in the same facility from starting concurrently:
 - a) When starting one load, inhibit start logic for all other such equipment until the load being started is up to speed (RVSS or VFD), or after a setpoint time delay (full-voltage starters and miscellaneous equipment).
 - j. Speed control:
 - 1) Modulate speed on VFD-driven motors using jog and hold, or PID control algorithms to maintain process conditions as described in the specific loop descriptions.
 - 2) Operate speed control within a pre-defined range:
 - a) Minimum speed as determined by equipment

manufacturer. The higher of:

- (1) Minimum motor speed to maintain adequate cooling for the type of load driven (constant or variable torque).
 - (2) Minimum equipment speed, such as minimum speed to deliver flow or to deliver minimum flow for equipment cooling or lubrication.
- b) Maximum speed 100 percent (60 hertz) or as identified by equipment manufacturer.
- 3) Where multiple equipment may operate together to maintain the same process condition:
- a) Provide an operator selection for starting sequence.
 - b) Start the first equipment at a preset starting speed.
 - c) When one or more equipment is running, and the speed control algorithm reaches a preset "Start Next" speed value (initially 95 percent of speed range) through a preset time delay:
 - (1) Start the next available equipment at the preset starting speed.
 - (2) Ramp up the started equipment and ramp down the previously running equipment to the mid operating speed (adjustable in the PLC). Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with the new load running at the mid speed (for example if one pump is running and the second pump will be added, then the total flow of both pumps running at mid operating speed should be approximately the same as flow of one pump at Start Next speed).
 - (3) Once both equipment reaches the mid operating speed, resume the speed control algorithm for those equipment.
 - (4) Operate all equipment at the same speed following the output of the speed control algorithm.
 - d) When two or more pieces of equipment are running, monitor for a "Stop Next" condition:
 - (1) Where flow rate is monitored, use a preset "Stop Next" flow rate for each possible number and combination of equipment:
 - (a) Determine initial "Stop Next" speed based on the flow that can be provided with one fewer piece of equipment running at a speed slightly below the "Start Next" speed.
 - (2) When the "Stop Next" condition exists through a preset time delay:
 - (a) Ramp speed of running equipment except for the equipment to be stopped up to a preset value based on the number of items running. Determine preset values for each condition based on equipment and system characteristics

to provide approximately the same total flow or process condition with one fewer load running (typically slightly below the preset "Start Next" speed) while ramping speed of equipment to be stopped down to the preset minimum speed.

- (b) Operate all remaining equipment at the same speed following the output of the speed control algorithm. Stop the load once it reaches minimum speed.

18. Gate and valve control:

- a. Monitor the device's LOCAL-STOP-REMOTE (LSR) switch(es) (the integral switch in the actuator or hard-wired switch at the local control station):
 - 1) Display current REMOTE status on PCS screens.
- b. Start an "Open Activation" timer whenever the device is expected to be open (PLC has issued an OPEN command in PCS AUTO, or OPEN was selected in PCS HAND):
 - 1) Initially set "Open Activation" time to twice the normal opening time.
 - 2) If the LSR position and open command do not change, and the PLC does not receive fully open status feedback within the "Open Activation" time period:
 - a) De-activate the open output.
 - b) Place the device in a "Failed" state.
 - c) Generate a "Failed to Open" alarm.
- c. Start a "Close Activation" timer whenever the device is expected to be closed (PLC has issued a CLOSE command in PCS AUTO, or CLOSE was selected in PCS HAND):
 - 1) Initially set "Close Activation" time to twice the normal closing time.
 - 2) If the LSR position and close command do not change, and the PLC does not receive fully closed status feedback within the "Close Activation" time period:
 - a) De-activate the close output.
 - b) Place the device in a "Failed" state.
 - c) Generate a "Failed to Close" alarm.
- d. Limit the number of open/close /commands so that it does not exceed the manufacturer requirements.
- e. For modulating valves (valves controlled from either a 4-20 mA signal or digital communications command) with position feedback, start a "Position Error" timer whenever the position feedback differs from the required position command by more than a setpoint error when the LSR is in REMOTE:
 - 1) For analog modulating devices, error is determined by position feedback differing from position command by more than the setpoint error.
 - 2) For discrete modulating devices, error is determined by feedback not changing in the correct direction, or changing at less than a setpoint rate, when the OPEN or CLOSE PLC output is active.
 - 3) Initially set the "Position Error" time to 60 seconds.

- 4) If the LSR position does not change, and position error stays outside of the setpoint error through the "Position Error" time period:
 - a) Place the device in a "Failed" state.
 - b) Generate a "Position Fail" alarm.
 - f. Provide separate time delay settings for each function and for each device.
 - g. If the valve position inputs indicate an invalid state (i.e., valve open and closed at the same time), place the device in a "Failed" state and generate an "Invalid State" alarm.
 - h. Re-establish PLC control of a device in a "Failed" state only after one of the following:
 - 1) An operator turns the device's LSR switch out of REMOTE and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).
 - 2) An operator acknowledges the fault from PCS.
 - i. For all alarm conditions, control other devices (as stopping pumps, etc.) as stated in the individual loop descriptions to make the system safe.
 - j. For discrete modulating valves (valves positioned to intermediate positions to control process values through discrete OPEN and CLOSE outputs), count the number of actuations (OPEN or CLOSE commands) per hour in the PLC:
19. Breaker status:
 - a. Display the following data to the extent it is available from the specified device:
 - 1) Open.
 - 2) Closed.
 - 3) Tripped.
 - 4) Ground fault.
 - 5) Settings.
 - 6) Racked out.
20. Power Data:
 - a. Retrieve data from:
 - 1) Power Quality Meters (PQMs) at 480V.
 - 2) Main Breaker Protective Relays on 12.47 kV Switchgear.
 - 3) Generator Master Control Panel.
 - 4) Digital bus networks, as indicated.
 - 5) Where available, use EtherNet IP communications.
 - b. Display the following data (to the extent it is available) from the specified device.
 - 1) Current XXXX.X A:
 - a) A-Phase.
 - b) B-Phase.
 - c) C-Phase.
 - 2) Volts: XXXX.X V:
 - a) A-Phase.
 - b) B-Phase.
 - c) C-Phase.

- 3) Reactive power: XXXX.X kVAR.
 - 4) Real power: XXXX.X kW.
 - 5) Apparent power: XXXX.X kVA.
 - 6) Power factor: 0.XX.
 - 7) Energy: XXXXXXXX kW*hr.
 - 8) Demand peak: XXXX Amp.
 - 9) Demand peak: XXXX kW.
 - c. For engine/generator system monitoring, also display percent of rated output.
21. Power Supply and Distribution displays Power Quality Meters display:
- a. In addition to the Power Data listed above, display the following (where available) from PQMs, Protective Relays, and Generator Master Control Panel:
 - 1) Frequency: Hertz.
 - 2) THD (current and voltage): up to 31st harmonic.
 - b. Calculate, indicate, historize, and trend data in a 12.47 kV Meter Table that lists measurements from the following Protection Relays:
 - 1) Protection Relay on 52-G1.
 - 2) Protection Relay on 52-G2.
 - 3) Protection Relay on 52-M1.
 - 4) Protection Relay on 52-M2.
 - 5) Protection Relay on 52-M3.
 - 6) Display calculated values for "Load At 12.47 kV", which sums the current, kW, and kW-hr values for all five Protection Relays.
 - 7) Display calculated values for "Load At 480V", which sums the current, kW, and kW-hr values for all PQM meters.
 - 8) Display calculated values for "Transformer and Line Losses", which subtracts "Load at 480V" from "Load At 12.47 kV" for current, kW, and kW-hr values for all PQM meters.
 - c. Display the data in a 480V Meter Table that lists measurements from all power quality meters on the plant.
22. Digital bus Starters, RVSS and VFDs equipped with EtherNet IP communications:
- a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below.
 - b. Communicate start and stop commands and receive running feedback over the fieldbus network.
 - c. Provide data entry screen for the cost of electricity in dollars per (kw*hr), which will be used in calculations for display.
 - d. Monitor the following additional values, and display on the HMI:
 - 1) Motor current, phase A, B, and C.
 - 2) Over current alarm.
 - 3) Under current alarm.
 - 4) Running status.
 - 5) Phase loss.
 - 6) Stall.
 - 7) Number of starts.
 - 8) History of past 5 trips.

- e. Calculate, indicate, historize, and trend, the following additional values:
 - 1) Full Load Amps (static value, ENGINEER will provide).
 - 2) Average Motor Operating Current.
 - 3) Run Time (Hours).
 - 4) Operating Hours (Hours/Year).
 - 5) Average Load Factor (equals Average Motor Current Operating Current/Full Load Amps) - display as a percentage.
 - 6) Annual Energy Use (kW*hr).
 - 7) Annual Operating Cost (dollars).
 - 8) Percent of Site Electric Use (equals Annual Energy Use/Sum of Annual Energy (kW*hr) values for all PQM meters).
 - f. For Variable Frequency Drives:
 - 1) Speed command.
 - 2) Speed feedback.
 - g. For RVSS, Variable Frequency Drives, and where otherwise shown or available, monitor the following over the digital bus network:
 - 1) Line voltage.
 - 2) Power.
 - 3) Power factor.
 - 4) Over voltage alarm.
 - 5) Under voltage alarm.
 - 6) Over current alarm.
 - 7) Under current alarm.
 - 8) Indicate, historize, trend, and alarm data as indicated in the ACS I/O Tables on the Drawings.
23. Calculate, indicate, historize, and trend plant-wide calculated values for kW by the following Groups.
- a. Calculated values (summed from starter data for all equipment within the Groups identified below):
 - 1) Demand peak: XXXX Amp.
 - 2) Demand peak: XXXX kW.
 - 3) Electric Power Consumption, by Process Group (kW): XXXX kW.
 - 4) Electric Power Consumption, by Process Group (percent): XX.XX percent (equals Electric Power Consumption, by Process Group (kW)/Sum of Electric Power Consumption on all 480V Meters).
 - 5) Electric Energy Consumption, by Process Group (kW*hr): XXXX kW*hr.
 - 6) Electric Energy Consumption, by Process Group (percent): XX.XX percent (equals Electric Energy Consumption, by Process Group (kW)/Sum of Electric Energy Consumption on all 480V Meters).
 - b. Groups - Engineer to provide lists of starters (FVNR, RVSS, VFD, and monitored feeder breaker) associated with each of the following treatment processes.
 - c. Display a Process Energy Consumption Table that lists the calculated values for each of the identified Groups.
 - d. Display a Process Energy Pie Graph that portions wedges according to the values calculated in Electric Energy Consumption, by Process Group (5). Label wedges, (with numeric percentage), for Groups to cover at least 90 percent of the Pie Graph. The remainder wedge of

- Pie Graph area can be labelled as "Other" (with numeric percentage).
24. Power failure:
- a. Retain all operating setpoints during power failure.
 - b. Restore plant operation to the state it was before the power loss:
 - 1) Store the operating state of all major equipment and systems in the PLC and retain the last state during a power loss.
 - c. Provide an operator selection to permit the plant to re-start. Once re-start is selected:
 - 1) Allow plant loads to re-start and allow loads to sequence on and ramp up following normal control logic. Where loads were operating in PCS HAND, restore their operation to the state before the power loss.
 - 2) Use the logic described above for preventing concurrent starts to provide necessary delays between each start.
 - d. Operating on generator power:
 - 1) Include running and starting kW and kVA requirements for each major equipment and system in registers in the PLC:
 - a) Where running load can vary due to speed, valve position, etc., use the normal starting value plus 25 percent of the difference between the maximum and minimum values.
 - 2) Inhibit starting of loads from process control logic and from operator selection (in PCS HAND) that will exceed generator capability.
 - 3) Generate the following alarms:
 - a) Generator near capacity: When measured kW or kVA reaches 90 percent of the rating of the generator.
 - b) Generator at capacity: When measured kW or kVA reaches 95 percent of the rating of the generator.
 - c) Unable to start: When an operator selects a load that would exceed generator starting or running capacity.
 - d) Insufficient capacity: When the control system needs to start a load, but is inhibited due to generator capacity.
 - 4) Whenever the Generator at Capacity alarm is active, inhibit starting of any loads, and inhibit increase in speed of all control loops, and other changes that would increase electrical load.
 - 5) Display the following power system data on the HMI and LOI in numerical and graphical formats:
 - a) Available power.
 - b) Current power demand.
 - c) Capacity of the generator.
 - d) Current power demand load as a percentage of capacity.
 - e) Generator frequency.

3.2 PROCESS CONTROL STRATEGIES

A. GENERAL:

1. Brief descriptions of process control for the pump station is detailed in the below section. ICSC shall coordinate with OWNER and ENGINEER for control logic optimization and modifications.

2. General programming guidelines and common control functions described in Article 3.1 shall be followed and used in conjunction with the process control strategies to provide a fully functioning operating system.

B. PUMP STATION CONTROL PANEL (PSCP):

1. General:
 - a. Pump Station Control Panel includes signals from Three (3) Main Pumps and associated components, One (1) conditioning pump, Wet Well Level Instruments and floats, Main Pumps Discharge Flow Meter, and Main Pumps Discharge Pressure.
2. Wet Well Level:
 - a. Wet Well level shall be monitored by two level instruments, LT-1002 and LT-1003. Wet Well level as read by the instruments shall be used for the primary control of pumps. Provide soft controls at the OIT / SCADA HMI for the operator to select the active instrument to be used for pumps control. When the active instrument is out of service or unavailable, the secondary instrument shall be automatically assigned as the active instrument for pumps control. When the conditioning pump is running, the active instrument shall be automatically set to LT-1003 (submersible pressure transducer). Operator shall have the option to override this condition and select any instrument as active.
 - b. If the two wet well level sensor readings differ by an operator adjustable value, an alarm shall be generated, regardless of which level sensor is selected as Active.
3. Main Pumps:
 - a. Each pump shall have local controls from the starter control panel as indicated in the Contract Drawings. When the Local/Off/Remote selector switch is in the Local position, the start/stop push buttons shall control the pump. When the Local/Off/Remote selector switch is in the Remote position, pump control shall be based on the control signal received from the PCSP. Operation of the pumps under normal conditions shall be automatic by the PLC in the PSCP. Soft controls shall be available to the operator at the OIT located on the PSCP and existing SCADA workstations. When the Local/Off/Remote selector switch is in the Remote position, the pumps shall operate as follows:
 - 1) Each pump shall operate in either MANUAL or AUTO mode. The mode shall be operator selectable via a soft hand switch. Manual control is intended for maintenance and emergency operation. In MANUAL mode, start/stop control of the pump shall be by the soft pushbuttons on the OIT / SCADA HMI. In Auto mode, the pump shall be controlled as follows:
 - a) The pumps shall operate in a Lead/Lag1/Lag2 configuration. The operator shall be able to select the Lead/Lag1/Lag2 status directly or select an "Auto

Alternation" mode based on pump runtimes.

- b) The pump selected as Lead shall start when the level reaches an operator adjustable Lead Start setpoint (initial value: 5 ft).
 - c) The pump selected as Lag1 shall start when the level reaches an operator adjustable Lag1 Start setpoint (initial value: 6 ft) or if the Lead pump fails to start 30 seconds after being requested to run.
 - d) The pump selected as Lag2 shall start when the level reaches an operator adjustable Lag2 Start setpoint (initial value: 7 ft) or if the Lag1 pump fails to start 30 seconds after being requested to run.
 - e) All pumps shall stop when the level drops below an operator adjustable Pump stop setpoint (initial value: 3 ft).
 - f) Low- level float (LSL-1001) shall be used as a safety interlock for the pump operation.
- 2) In any mode of operation if the following conditions occurs, the pump shall shut down, and an alarm shall be generated.
 - a) RVSS Fault
 - b) Motor Winding High Temperature
 - c) Motor Housing Leakage
 - 3) In any mode of operation, if the E-Stop pushbutton is pressed, the pump shall stop, and an alarm shall be generated.
- b. All setpoints shall be operator adjustable. Timers shall be programmed in the PLC to avoid frequent starting and stopping of the pumps due to level fluctuations.
 - c. In the event of a PLC failure or if both the level instruments are unavailable, the system shall automatically switch to backup mode of control. Refer to section 40 67 00 Control Panels and Components for backup relay logic.
- 4. Conditioning Pump:
 - a. The condition pump shall have local controls from the starter control panel as indicated in the Contract Drawings. When the Local/Off/Remote selector switch is in the Local position, the start/stop push buttons shall control the pump. When the Local/Off/Remote selector switch is in the Remote position, pump control shall be based on the control signal received from the PCSP. Operation of the pumps under normal conditions shall be automatic by the PLC in the PSCP. Soft controls shall be available to the operator at the OIT located on the PSCP and existing SCADA workstations. When the Local/Off/Remote selector switch is in the Remote position, the pumps shall operate as follows:
 - 1) The pump shall operate in either MANUAL or AUTO mode. The mode shall be operator selectable via a soft hand switch. In MANUAL mode, start/stop control of the pump shall be by the soft pushbuttons on the OIT / SCADA HMI.

- 2) In Auto mode, the pump shall be controlled based of a ON / OFF timer. Pump shall run for the duration of the ON timer and shall remain stopped for the duration of the OFF timer. The timer setpoints shall be made operator adjustable. Operator shall be able to enable and disable the timer mode.
 - 3) Low- level float (LSL-1001) shall be used as a safety interlock for the pump operation.
 - 4) Conditioning pump shall not run when any one of the Main Pumps are running. While the conditioning pump is running if the level in the wet well raises to a condition such that main pumps are required to run, the conditioning pump shall be stopped, and timers reset.
 - 5) In any mode of operation if the following conditions occurs, the pump shall shut down, and an alarm shall be generated.
 - a) Overload
 - b) Motor Winding High Temperature
 - c) Motor Housing Leakage
 - 6) In any mode of operation, if the E-Stop pushbutton is pressed, the pump shall stop, and an alarm shall be generated.
5. Diesel Engine Pumps:
- a. Diesel Engine Pump is intended to provide pumping capabilities when the station loses power or during an emergency when the main pumps have failed to maintain the wet well level.
 - b. To achieve this, the High level (LSH-1001) and Low-Level (LSL-1001) floats are hardwired to the diesel engine pump directly. A high level in the wet well shall start the diesel pump. The pump shall continue to run until the level in the wet well gets below the Pump Stop float.
 - a. Diesel Engine Pump shall have no integration with the PSCP. Available monitoring signals from the diesel engine pump shall be wired to the Mission RTU. Configuration of the Mission RTU and displays at the Mission Web Server shall be provided by Mission control Field technicians.
 - b. ICSC shall coordinate with Mission Control field technicians and configure the diesel engine pump monitoring signals for display at the SCADA Workstations over the OWNER's existing SCADA interface with Mission Web Server.

3.3 DEMONSTRATION AND TRAINING

As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems and Section 40 80 00- Commissioning for Instrumentation and Controls.

+ + END OF SECTION + +

SECTION 40 63 00

CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Programmable logic controller (PLC) based control systems hardware.
 - 2. Development software to be used with the specified PLC hardware.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Institute of Electrical and Electronics Engineers (IEEE).

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 - 1. CPU: Central processing unit.
 - 2. I/O: Input/Output.
- C. Specific definitions:
 - 1. Development operating software: The software provided by the PLC manufacturer for use in programming the PLC.
 - 2. Application software: The software that is programmed specifically for the Project.

1.4 SYSTEM DESCRIPTION

- A. Provide all PLC hardware as indicated on the Drawings and as specified in this Section.
- B. The following panels shall be provided with new Allen Bradley PLCs as specified herein:
 - 1. Pump Station Control Panel (PSCP).

1.5 SUBMITTALS

- A. Furnish submittals as specified in 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
 - 1. CPU:
 - a. Processor type.
 - b. Processor speed.

- c. Memory.
 - d. Internal processor battery backup time.
- 2. I/O modules:
 - a. Type.
 - b. Standard wiring diagram.
- C. Calculations:
 - 1. Submit calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use PLC manufacturer's calculation or estimating worksheet.
 - 2. Submit calculations to verify that spare I/O requirements of this Section are met.
 - 3. Submit calculations to verify that PLC power supply requirements of this Section are met.
- D. Product data:
 - 1. Programming languages.
 - 2. Operating system requirements.
- E. Control logic:
 - 1. Fully annotated copy of programmed PLC logic.
 - 2. Cross-referenced index of all PLC registers or points.
- F. Provide application software for the specific Project process requirements.
 - 1. Fully annotated copy of programmed PLC logic in its native format.
 - 2. Cross-referenced index of all PLC registers or points.

1.6 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO 9001.
- C. Additional requirements:
 - 1. Provide PLC system components by a single manufacturer:
 - a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.
 - 2. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.
 - 3. All PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.8 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.9 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.10 MAINTENANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. In addition to the spare parts requirements specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems, furnish the following:
 - 1. CPU: 1 spare for each type of CPU in the system.
 - 2. I/O cards: 1 spare for each type of I/O card in the system.
 - 3. Power supplies: 1 spare for every type of power supply in the system.
 - 4. Network/communications cards: 1 spare for every type of network or communications card in the system.
 - 5. Remote adapter: 1 spare for every type of remote adaptor in the system.
 - 6. Chassis: 1 spare for each chassis size in the system.
 - 7. Communication cable: 1 spare for each type of cable used in the system.
- C. Installed spare requirements:
 - 1. I/O points:
 - a. Provide total of 25 percent spare I/O capacity for each type of I/O at every PLC and remote inputs and outputs (RIO).
 - b. Wire all spare I/O points to field terminal blocks in the same enclosure the PLC resides in.
 - 2. PLC backplane capacity:
 - a. Provide 25-percent or 3 spare backplane slots, whichever is greater, in all racks containing I/O.
 - 3. PLC memory:
 - a. Provide 50-percent spare program volatile memory.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. One of the following or equal:
 - 1. Rockwell Automation:
 - a. ControlLogix L8 series.
- B. The PLC programming software system shall be manufactured by PLC hardware manufacturer:
 - 1. Rockwell Software:
 - a. Studio 5000 for ControlLogix.
 - 2. Coordinate exact software versions to use for programming with the OWNER.

2.2 MANUFACTURED UNITS

- A. Programmable logic controller:
 - 1. Construction:
 - a. Furnish plug-in modular system.
 - b. Provide PLCs capable of operating in a hostile industrial environment without fans, air conditioning, or electrical filtering:
 - 1) Temperature: 0 to 60 degrees Celsius.
 - 2) RFI: 80 to 1,000 MHz.
 - 3) Vibration: 10 to 500 hertz.
 - 4) Humidity: 0 to 95 percent.
 - c. Provide internal power supplies designed to protect against overvoltage and frequency distortion characteristics frequently encountered with the local power utility.
 - d. Design the PLC system to function as a standalone unit that performs all of the control functions described in this Section completely independent from the functions of the HMI system PC-based operator interfaces:
 - 1) Failure of the HMI system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
 - 2. CPU:
 - a. Configure each CPU so that it contains all the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.
 - b. Capable of interfacing with all discrete inputs, analog inputs, discrete outputs, analog outputs, and communication cards to meet the specified requirements.
 - c. Capable of supporting and implementing closed-loop floating-point math and PID control that is directly integrated into the CPU control program.
 - 3. Memory:
 - a. Non-volatile memory: On-board complementary
 - b. metal-oxide-semiconductor (CMOS), electrically erasable programmable read-only memory (EEPROM), PCMCIA, compact flash card, or SD card.
 - c. Supply with sufficient memory to implement the specified control functions plus a reserve capacity as specified with the requirements of this Section:
 - 1) Reserve capacity:
 - a) Totally free from any system use.
 - 2) Programmed in a multi-mode configuration with multiple series or parallel contacts, function blocks, counters, timers, and arithmetic functions.
 - 4. Programming:
 - a. Provide a system where processors are programmed by:
 - 1) Portable laptop computer both locally and via the PLC control network.
 - 5. PLC power supply:
 - a. Input:
 - 1) 120 VAC for all ControlLogix PLC.
 - b. Mounted in the PLC housing or as indicated on the Drawings.

- c. Sized to power all modules mounted in that housing including an average module load for any empty housing slots plus 50 percent above that total.
- 6. PLC input/output, I/O modules:
 - a. General:
 - 1) Compatible with all of the PLCs being furnished under the contract and by the same manufacturer as the PLCs.
 - 2) Provide I/O modules that:
 - a) Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
 - b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
 - c) Accept dual-ended inputs.
 - 3) The use of common grounds between I/O points is not acceptable.
 - 4) Provide modules that are removable without having to disconnect wiring terminals:
 - a) Utilize a swing-arm or plug-in wiring connector.
 - 5) Provide at each PLC the I/O modules for the following:
 - a) Designated future I/O points contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies.
 - b) Installed spare capacity in accordance with the requirements of this Section.
 - c) Wire all spares provided to the field terminal strip.
 - 6) Condition, filter, and check input signals for instrument limit conditions.
 - 7) Filter, scale, and linearize the raw signal into an engineering-units-based measurement.
 - 8) Alarm measurements for high, low, rate-of-change limits, and alarm trends.
 - 9) Provide external fuses mounted on the field connection terminal block for all discrete input, discrete output, and analog input I/O points.
 - 10) When multiple cards of the same I/O type are provided and parallel equipment, instrumentation, or redundant processes exist, distribute I/O among cards to ensure that a single card failure will not render an entire process unavailable.
 - b. Discrete input modules:
 - 1) Defined as contact closure inputs from devices external to the input module.
 - 2) Provide inputs that are optically isolated from low-energy common-mode transients to 1,500 volts peak from users wiring or other I/O modules.
 - 3) Individually isolated inputs.
 - 4) With LEDs to indicate status of each discrete input.
 - 5) Input voltage: 24VDC.
 - 6) Provide input module points that are individually fused with blown-fuse indicator lights, mounted external of the module on the output terminal strip:
 - a) Coordinate external fuse size with the protection located on the module, so that the external fuse opens first under a fault condition.
 - c. Discrete output modules:

- 1) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
 - a) Triac outputs may be used, with the permission of the ENGINEER. Care must be used in applying this type of module to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.
 - 2) Optically isolated from inductively generated, normal mode and low-energy common-mode transients to 1,500 volts peak.
 - 3) LEDs to indicate status of each output point.
 - 4) Output voltage: 24VDC.
 - 5) Individually isolated outputs.
- d. Analog input modules:
- 1) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
 - 2) Analog-to-digital conversion: Minimum 12-bit precision with the digital result entered into the processor.
 - 3) The analog-to-digital conversion updated with each scan of the processor.
 - 4) Individually isolated each input.
 - 5) Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.
- e. Analog output modules:
- 1) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
 - 2) Individual isolated output points each rated for loads of up to 1,000 ohms.
 - 3) HART analog input module:
 - a) Channels per module: 4 minimum.
 - b) Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).
 - c) Each channel can individually have HART enabled or disabled.
 - d) Flash-upgradeable firmware.
 - e) Mounts in slot in PLC backplane.
 - f) Modules shall be configured using the specified PLC programming software.
 - 4) HART analog output module:
 - a) Channels per module: 4 minimum.
 - b) Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).
 - c) Each channel can individually have HART enabled or disabled.
 - d) Flash-upgradeable firmware.
 - e) Mounts in slot in PLC backplane.
 - f) Modules shall be configured using the specified PLC programming software.
7. Communications modules:
- a. Network communications modules:
- 1) General:
 - a) Install communications modules in the PLC backplane.
 - 2) Ethernet:

- a) Ports: 2 RJ-45.
 - b) Communication rate: 100 Mbit/s.
 - c) Allen-Bradley ControlLogix - 1756-EN2TR.
 - 3) Provide all network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.
- 8. PLC backplane housing:
 - a. Mount the PLC power supply, CPU, communications module, and I/O modules in a suitable standard PLC backplane or housing.
 - b. Provide spare slots in each PLC and RIO location in accordance with the requirements of this Section.
 - c. Provide a blank slot filler module for each spare slot.
- B. PLC programming software:
 - 1. Furnish operating software capable of monitoring and/or controlling the PLCs via the PLC data network:
 - a. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
 - b. Monitor devices at each drop on the PLC data network for proper communications.
 - c. Provide the ability to program all PLCs on the PLC data network from the ENGINEER's console.
 - 2. PLC programming laptop/desktop operating system:
 - a. Microsoft Windows 10.
 - 3. The PLC programming software shall be suitable for the PLCs specified above.
 - 4. PLC programming software for all programming, monitoring, searching, and editing:
 - a. Usable both on-line, while connected to the PLC, and off-line.
 - b. The operating software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical function blocks.
 - c. Capable of disabling/forcing all inputs, outputs, and coils to simulate the elements of the ladder logic; forced elements shall be identifiable by means of color change.
 - d. Include a search capability to locate any address or element and its program location.
 - e. Display at the EC, PLC status information, such as faults and communication errors and amount of memory remaining.
 - 5. The PLC programming software shall support the following programming languages:
 - a. Ladder Diagram.
 - b. Function Block Diagram.
 - c. Structured Text, where approved.
 - 6. Generate a PLC program printout, which is fully documented, through the PLC programming software:
 - a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line-by-line basis.
 - b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.
 - c. Use a mnemonic associated with each contact, coil, etc. that describes its function.

- d. Utilize the tag and loop identification as contained in the P&IDs:
- e. If additional internal coils, timers, etc. are used for a loop, they shall contain the loop number.
- f. Provide a cross-reference report of program addresses.
- 7. Software functions automatically without operator intervention, except as required to establish file names and similar information:
 - a. Furnish the operating system software that is the standard uncorrupted product of the PLC manufacturer with the following minimum functions:
 - 1) Respond to demands from a program request.
 - 2) Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.
 - 3) Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are ensured.
 - 4) Queuing of requests in order of priority if one or more requested resources are unavailable.
 - 5) Resolution of contending requests for the same resource in accordance with priority.
 - 6) Service requests for execution of one program by another.
 - 7) Transfer data between programs as requested.
 - 8) Management of all information transfers to and from peripheral devices.
 - 9) Control and recovery from all program fault condition.
 - 10) Diagnose and report real-time hardware device errors.
- 8. Program execution:
 - a. Application software - program execution scheduled on a priority basis:
 - 1) A multilevel priority interrupt structure is required.
 - 2) Enter into a list of pending programs a program interrupted by a higher priority program:
 - a) Resume its execution once it becomes the currently highest priority program.
 - 3) Schedule periodic programs.
 - 4) Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.
- 9. Start-up and restart:
 - a. Provide software that initializes and brings a PLC or any microprocessor-based hardware unit from an inactive condition to a state of operational readiness.
 - b. Initialization:
 - 1) Determination of system status before start-up of initializing operating system software and initializing application software.
 - 2) Loading of all memory-resident software, initializing timers, counters, and queues, and initialization of all dynamic database values.
- 10. Shutdown:
 - a. Where possible, provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.

- b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.
 - c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.
 - d. Alarm PLC failure at the operator interface level.
- 11. Diagnostics:
 - a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
 - b. Use the manufacturer's standard diagnostic routines as much as possible.
 - c. Furnish diagnostic software and test programs for each significant component in the control system.
 - d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.
- 12. Calendar/time program:
 - a. The calendar/time program to update the second, minute, hour, day, month, and year and transfer accurate time and date information to all system-level and application software.
 - b. Variations in the number of days in each month and in leap years must be handled automatically by the program.
 - c. The operator must be able to set or correct the time and date from any operator interface, only at the highest security level.
- 13. Algorithms:
 - a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
 - b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.
 - c. Algorithms must include alarm checks where appropriate.
 - d. Provide, as a minimum, the following types of algorithms:
 - 1) Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
 - 2) A switch algorithm, which reads the current and value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated: 2 outputs with 1 input and 1 output with 2 inputs.
 - 3) A 3-mode proportional-integral-derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supports both direct and reverse-acting modes.
 - 4) Lead, lag, dead time, and ratio compensators.
 - 5) Integration and totalization of analog process variables.
- 14. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:
 - a. In addition, provide spare database points for future expansion.
- 15. One integrated database can be utilized for all types of analog points or separate databases for each type; in either case, the database for each point must include all specified aspects.
- 16. All portions of the database must be available for use by the display, report, and other specified software modules.
- 17. All the data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as

well as modifying defined points through these displays. This point definition and modification must include all of the features and functions defined below. The analog database software must support the following functions and attributes:

- a. Analog input signal types:
 - 1) Provide software at the remote terminal units (RTUs) and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.
- b. Input accuracy:
 - 1) Inputs must be read with an accuracy of within 0.05-percent full-scale or better.
 - 2) Data conversion errors must be less than 0.05-percent full-scale.
 - 3) Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once per minute.
 - 4) Maintain for a minimum of 1 year the system accuracy stated above without adjustments.
- c. Blocking:
 - 1) Provide mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.
 - 2) For any input so blocked, the operator may manually enter a value to be used as the input value.
- d. Filtering:
 - 1) For each analog input, provide a first order lag digital filter with an adjustable filter factor.
- e. Linearizing:
 - 1) Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.
- f. Calculated values:
 - 1) Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated values, constants, etc.
 - 2) These values must be handled the same as real inputs in terms of record-keeping, alarming, etc.
- g. Scaling and zero suppression:
 - 1) Provide a conversion program to convert input values into engineering units in a floating-point format.
- h. Alarms:
 - 1) Provide an alarm program to check all analog variables against high-high, high, low, and low-low alarm limits.
 - 2) When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.
 - 3) Provide an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit.
 - 4) Must be possible to inhibit alarms based on external events, e.g.,
 - 5) lock-out low pump flow alarm when the pump is off.
- i. Averages:
 - 1) Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.
 - 2) Continuously compute averages, e.g., the average for the current period to the present point in time must be stored in memory and

- available for use in displays, etc.
 - 3) Update hourly averages each minute or at the polling interval for the selected variable.
 - 4) Update daily averages at least once each hour and calculate using the results of the hourly averages.
 - 5) Update monthly averages at least once each day and calculate using the results of the daily averages.
 - 6) At the end of each averaging period, store the average values for the period on the hard disk for historical record-keeping and reset the present period average register to the present value of the variable.
 - 7) The active database must include the present period average and previous period average for each variable and averaging period.
- j. Totals:
 - 1) Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.
 - 2) Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.
 - 3) Assign a separate factor for each totalizing interval.
 - 4) Variables for which totalization is inappropriate must have scaling factors of zero.
 - 5) At the end of each totalizing period, store the totalized values for the period on the hard disk for historical record-keeping and reset the present period totalization register to zero.
 - 6) The active database must include the present period total and previous period total for each variable and totalizing period.
- k. Engineering units:
 - 1) Provide software to allow the system and the operator to convert all the measured analog variables to any desired engineering units.
 - 2) The operator must be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in gpm, mgd, cfs, and acre-feet per day.
 - 3) Pre-program the conversion of the engineering units, and, if not pre-programmed, the operator must be able to program new engineering unit conversions by using simple methods, e.g., multiplication of the database attributes by a constant.
 - 4) The programming method must be at a level and compatible with the specified training of the operator and the OWNER's personnel.
 - 5) New conversions must not require the services of a special programmer and/or special, high-level, programming training.
- l. Control modules:
 - 1) For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.
 - 2) Input and output assignments, setpoints, and constants must be adjustable by the operator through the operator interface.
 - 3) Provide control algorithms for manual control with output values adjustable by the operator.
- m. Analog outputs:
 - 1) Analog outputs must be maintained as part of the database.

- 2) These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.
 18. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.
- C. General control functions:
1. Analog control functions:
 - a. PID, lead/lag, signal select, alarm, limit, delay, and time base.
 - b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR, and NXOR functions.
 - c. All math utilities must be linkable to process data points or manual inputs via control block configuration.
 - d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.
 2. Discrete control functions:
 - a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays, and time base.
 3. Software support:
 - a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.
 - b. Call each function as required by the configured controls to perform the intended function.
 4. Control and status discrepancies:
 - a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.
 - 1) For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator-programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.
 - b. Involuntary change in the device's status must also generate an alarm:
 - 1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.
 - c. Each command, status, and alarm must cause the color of the symbol to change.
 - d. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay period selected to be longer than the operating period of the control element:
 - 1) Delay periods for each final control element must be adjustable at the operator interface.
 - 2) List all time delays in the final documentation.
 5. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

D. Control configuration:

1. Provide software to allow control strategies to be developed, and their operation initiated through the operator interface.
2. Provide standardized control point displays for defining the control functions including the function type, input/output addresses, setpoints, tuning constants, etc.
3. Provide a mechanism to link separate control functions together into an integrated control strategy.
4. Provide a mechanism to download operational/control setpoints developed at any operator interface to any PLC or RTU for operational implementation.
5. Provide a mechanism to define and implement operational/control setpoints locally at the PLC or RTU, and to upload them to the operator interface for operational record-keeping.
6. Perform control configurations on-line at the operator interface; the PLC or RTU may be taken off-line when being configured or downloaded.

2.3 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.
- B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:
1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.
- C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.
- D. General:
1. The control system logic program shall reside at the PLC level.
- E. Use the tag and loop identifications found on the P&IDs for all tags used and/or assigned as part of the application software work provided by the ICSC.
- F. Program the PLC logic using the following language(s):
1. Ladder Diagram.
 2. Function Block Diagram.
 3. Structured Text, where approved.

3.2 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

- A. Provide a minimum of 4 USB Flash Drive copies of the following:

Home Depot MPS and FM
Programmable Logic Controllers
30036073

1. Application software:
 - a. Finalized fully annotated copy of programmed PLC logic in its native format.
 - b. Cross-referenced index of all PLC registers or points.

3.3 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.

3.4 CLEANING

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.

3.5 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems and 40 80 00 – Commissioning for Instrumentation and Controls.
- B. Tailor training specifically for this Project that reflects the entire control system installation and configuration.
- C. Perform training by pre-approved and qualified representatives of the ICSC and/or manufacturer of the PLC hardware and programming software:
 1. A representative of the ICSC may perform the PLC hardware training only if the representative has completed the manufacturer's training course for the PLC hardware.
 2. A representative of the ICSC may perform the PLC programming software training only if the representative has completed the manufacturer's training course for the PLC programming software.

3.6 PROTECTION

- A. As specified in Section 40 60 00- Common Work Results for Process Control and Instrumentation Systems.

+ + END OF SECTION + +

SECTION 40 63 01

OPERATOR INTERFACE UNIT

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Local Operator Interface (LOI) control systems hardware and software.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.4 SYSTEM DESCRIPTION

- A. Provide all LOI hardware identified in the Contract Documents for Vendor provided systems requiring a local operator interface touchscreen.

1.5 SUBMITTALS

- A. Furnish submittals as specified in Sections 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
 - 1. Complete manufacturer's brochures for each item of equipment.
 - 2. Complete manufacturer's brochures that identify LOI software and options. Mark up to clearly show options and components to be provided, and cross out any options or components that will not be provided.
 - 3. Manufacturer's operation and installation instructions.
 - 4. Additional requirements:
 - a. Display type and size.
 - b. Operator input.
 - c. Processor type and speed.
 - d. Memory size.
 - e. Programming protocols.
 - f. Communication protocols.
 - g. Power requirements.
 - h. Operating temperature and humidity ranges. NEMA ratings.
- C. Shop drawings:
 - 1. Furnish the following:
 - a. System block diagram showing relationship and connections between devices. Include manufacturer and model information, and address settings.

- b. Mounting drawings with dimensions and elevations for each equipment location, including identification of all components, preparation and finish data, and nameplates.
 - c. Electrical connection diagrams.
 - d. Complete grounding requirements.
 - 2. Graphic Screens:
 - a. Color printouts of each graphic screen and all control pop-ups.
 - 3. Furnish data sheets for each component together with a technical product brochure or bulletin:
 - a. Manufacturer's model number.
 - b. Project equipment tag.
 - 4. Complete and detailed bills of materials identified by each cabinet. Include with each bill of material item the following:
 - a. Quantity.
 - b. Description.
 - c. Manufacturer.
 - d. Part numbers.
- D. Operation and maintenance manuals:
- 1. Complete installation, operations, calibration, and testing manuals as described in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- E. Record documents:
- 1. Electrical connection diagrams revised to reflect any changes made in the field and submitted as record Drawings.

1.6 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify that the LOI equipment is compatible with the installed conditions.
- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.
- D. Provide LOI hardware manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
- E. System compatibility:
 - 1. The software must be the standard operating software system designed specifically for use with the LOI hardware.
 - 2. The software must be furnished and developed by the manufacturer of the LOI hardware.

1.7 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.8 PROJECT OR SITE CONDITIONS

- A. Project environmental conditions as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
 - 1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.9 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.10 SYSTEM STARTUP (NOT USED)

1.11 OWNER'S INSTRUCTION (NOT USED)

1.12 COMISSIONING (NOT USED)

1.13 MAINTENANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide system upgrades and maintenance fixes for a period of 2 years from substantial completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. One of the following or equal:
 - 1. As indicated below.

2.2 MANUFACTURED UNITS

- A. Thin Client Computer:
 - 1. Manufacturers: The following or equal:
 - a. OnLogic ThinManager TM400
 - 2. General:
 - a. General purpose, PC-architecture thin client computers Thin Manager Ready.
 - b. Thin workstations combined with PCS Thin Manager server.
 - c. Form factor: Mini.

- d. Processor speed: Dual Core, 1.0 GHz or better.
- e. Memory: 4-GB DDR3 SDRAM.
- f. Flash memory: 4 GB.
- g. Network card: Dual 10/100/1000-Base-TX.
- h. ACP Enabled, PXE Boot.
- i. Ports:
 - 1) 4 USB 3.0.
 - 2) 2 RJ-45 Ethernet.
 - 3) 2 HDMI.

B. Thin Client, Touchscreen:

- 1. Manufacturers: The following or equal:
 - a. Arista
 - b. OnLogic, Cincoze series
 - c. Dynics
- 2. General:
 - a. Industrial Rugged Panel PC, PC-architecture thin client computers Thin Manager Ready.
 - b. Thin workstations combined with PCS Thin Manager server.
 - c. Form factor: Panel Mounted IP65 Rated Front Bezel, fanless.
 - d. Processor speed: Dual Core, 1.0 GHz or better.
 - e. Memory: 4-GB DDR3 SDRAM.
 - f. Flash memory: 4 GB.
 - g. Network card: Dual 10/100/1000-Base-TX.
 - h. ACP Enabled, PXE Boot.
 - i. Touchscreen Display Resolution: 1920 x 1080 Full HD
 - j. Touchscreen Display Size: 17-inch, minimum.
 - k. Ports:
 - 1) 4 USB 3.0.
 - 2) 2 RJ-45 Ethernet.
 - 3) 2 HDMI.

2.3 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.2 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

- B. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.
- C. Provide panel support bracing if more than 25 percent of the area has been removed to allow for the mounting of the LOI.
- D. All tags used and/or assigned as part of the application programming work are to use the tag and loop identifications found on the P&IDs.
- E. Station graphics:
 - 1) Configure the graphic display for each device both in the treatment plant, and/or process area, including but not limited to:
 - a. Symbols for:
 - 1) Pumps.
 - 2) Valves.
 - 3) Major instruments.
 - 4) Flowmeters.
 - 5) Pressure transmitter.
 - 6) Major equipment.
 - b. Alarm symbols including intrusion alarm.
 - c. Relevant test and operational data.
 - d. Status for each controller or controlled device:
 - 1) Hand-Off-Auto Status.
 - 2) Local-Off-Remote Status.
 - 3) Run.
 - 4) Call.
 - 5) Fail.
 - 6) Open.
 - 7) Close.
 - 8) Hold.
 - 9) Modulate.
 - 10) Running.
 - e. Depict a change of state of pumps and valves by a change in color.
 - 2) Production and usage bar graph:
 - a. Depict the production for each site and/or piece of equipment, as determined during the requisite graphics meeting, within the treatment plant, summarized to type, and total usage, with a bar graph and numeric value for each analog value.
 - 3) System level summary:
 - a. Show the level for the plant influent and effluent production, etc., via a display using bar graphs and numbers, as determined during the requisite graphics meeting.

3.3 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.4 CLEANING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.5 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.6 PROTECTION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

+ + END OF SECTION + +

SECTION 40 66 00

CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Materials and equipment used in process control and LAN networks including:
 - a. Control Panel mount Network switches.
 - b. Patch panels and other data network hardware.
 - c. Firewall
 - d. Related accessories.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 802.1X – Standard for Local and Metropolitan Area Networks—Port-Based Network Access Control.
 - 2. 802.3 - Standard for Ethernet.
 - 3. 802.3ab - Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T.
 - 4. 802.3u - Standards for Local and Metropolitan Area Networks: Supplement - Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100Mb/s Operation, Type 100BASE-T (Clauses 21- 30).
 - 5. 802.11b - Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher Speed Physical Layer (PHY) Extension in the 2.4 GHz band.
- C. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
 - 1. 568-C.3 - Optical Fiber Cabling Components Standard.
- D. Underwriters Laboratories, Inc. (UL).

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.4 SUBMITTALS

- A. Furnish submittals as specified in the Contract Documents and 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
 - 1. Include information on all network equipment.
 - 2. Manufacturer's operation and installation instructions.
- C. Shop drawings:
 - 1. Complete set of drawings including but not limited to:
 - a. System block diagram showing relationship and connections between devices provided under this Contract and existing equipment. Include manufacturer and model information, and address settings.
 - b. Network riser diagram.
 - c. Network port diagram, which physically locates all ports within the facility, and identifies their patch panel and switch port.
 - d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
 - e. Electrical connection diagrams.
 - f. Complete grounding requirements.
 - 2. Written configuration guidelines for each component including:
 - a. IP Addressing and VLAN configuration
 - b. General port and port security settings
 - c. General routing configuration
 - 1) Networks/VLANs with allowed communication
 - 2) Available communication paths
 - 3) Device to Device routes
 - 4) Static and Dynamic configurations and planned protocols
 - d. Descriptive Firewall ACLs
 - 3. Furnish data sheets for each component together with a technical product brochure or bulletin:
 - a. Manufacturer's model number.
 - b. Project equipment tag.
 - 4. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
 - a. Quantity.
 - b. Description.
 - c. Manufacturer.
 - d. Part numbers.
- D. Test reports:
 - 1. As specified in Sections:
 - a. 40 80 00 - Commissioning for Instrumentation and Controls.
 - 2. Signed test results as described in this Section.
 - 3. Test results shall include:
 - a. Narrative describing the test procedures followed.
 - b. Block diagram of test set up.
 - c. Manufacturer's information on test equipment used.
 - d. Detailed test results.

- E. A narrative summarizing the results of the testing and identifying any further

action required. Operating manuals:

1. Complete installation, operation, calibration, and testing manuals as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

F. Record drawings:

1. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.8 SCHEDULING

- A. Schedule a network design workshop with the OWNER to verify the following:
 1. General communication and routing methodology.
 2. Existing networks, subnets, and IP addressing and routing schemes.
 3. Network management requirements and existing systems that require new equipment to be integrated into.
 4. OWNER's Network Security requirements.

1.9 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Provide all network equipment identified in the Contract Documents.

2.2 MANUFACTURED UNITS

- A. Ethernet switches:
 1. Managed Ethernet switches for Control Panels:
 - a. Manufacturers: The following, no equal:
 - 1) Rockwell, Stratix 5700.

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- b. Properties:
 - 1) Hardware:
 - a) Power supply:
 - (1) Provide redundant power supplies.
 - (2) 24 VDC, 170 watts per power supply.
 - b) No fans or moving parts.
 - 2) Performance:
 - a) Enclosure:
 - (1) All metal housing.
 - (2) 15g Shock for 11ms minimum.
 - b) 10/100BASE-TX RJ-45 Copper Ports (quantity as indicated on the Drawings).
 - c) 100BASE-FX SC or ST Fiber Duplex Ports (quantity as indicated on the Drawings).
 - d) 1,000BASE-T RJ-45 Copper Ports (quantity as indicated on the Drawings).
 - e) 1,000Base-SX LC Duplex Fiber Ports (quantity as indicated on the Drawings).
 - f) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
 - (1) SNMP.
 - (2) VLAN.
 - (3) QoS.
 - (4) Port Mirroring.
 - (5) DHCP Server
 - g) IGMP Snooping with Ethernet I/P plug & play compatibility.
 - h) 802.1d, 802.1w, 802.1D RSTP.
 - 3) Environment:
 - a) Operating temperature range: 32 to 140 Degrees Fahrenheit.
 - b) Humidity: 10 to 95 percent, non-condensing.
 - 4) Connector type:
 - a) Fiber: LC.
 - b) Copper: RJ-45:
 - (1) Quantity of copper and fiber ports as required to provide connections as indicated on the Drawings: As required to provide the number of connections required plus 20 percent spare ports of each type used.
 - 5) Mounting:
 - a) DIN Rail mounting.

B. Patch panels:

1. General:

a. Fiber:

- 1) All optical fibers shall be provided with strain relief and terminated at a fiber patch panel. Final connections between the patch panel and the fiber optic network equipment shall be made via fiber optic patch cords.
- 2) All fibers, active and dark, shall be terminated at the patch

- panels.
- 3) Interconnect and patch panel housings shall provide space for excess fiber and provide strain relief for the fiber cable.
- 4) Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
- b. Copper:
 - 1) Final connections between the patch panel and network equipment shall be by patch cords.
 - 2) All premises cables shall be terminated at the patch panels.
 - 3) Cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out conductors.
 - 4) Maintain twist of broken out conductors per EIA/TIA standards.
- 2. Cabinet style fiber patch panels:
 - a. Wall mounted interconnect:
 - 1) Use for the termination of a single cable outside of cabinets, in small enclosures or as indicated on the plans.
 - 2) Wall mounted fiber interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
 - 3) Wall mounted fiber interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
 - 4) Capacity:
 - a) As shown on the plans, minimum 6 connections.
 - 5) Accessories:
 - a) Door lock.
 - b) Blanks for unused connector panels.
 - 6) Manufacturers: The following or equal:
 - a) Corning Cable Systems, Wall-Mountable Interconnect Center.
 - b) CommScope, FL1
 - c) Optical Cable Corporation
 - b. DIN rail mounted:
 - 1) Use for the termination of a single cable inside of cabinets, in small enclosures or as indicated on the plans.
 - 2) DIN rail mounted cable interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
 - 3) DIN rail mounted cable interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
 - 4) Capacity:
 - a) As shown on the plans, minimum 6 connections.
 - 5) Accessories:
 - a) Blanks for unused connector panels.
 - 6) Manufacturers: One of the following or equal:
 - a) Optical Cable Corporation, DTC series.
 - b) DINSpace, SNAP XL.
 - c) Panduit.

- C. Panel Mount Firewalls:
 - 1. Manufacturers: The following or equal:
 - a. CheckPoint 1200R.
 - 2. Properties:
 - a. 2 Gbps firewall throughput.
 - b. Ports:
 - 1) LAN: 4 x 10/100/1000Base-T RJ45 ports.
 - 2) DMZ: 1 x 10/100/1000Base-T RJ45 or 1 x 1000BaseF port.
 - 3) WAN: 1 x 10/100/1000Base-T RJ45 or 1 x 1000BaseF port.
 - c. Mounting:
 - 1) Provide mounting hardware.
 - 2) DIN rail mounting, unless otherwise indicated on the Drawings.
 - d. Environment:
 - 1) Operating temperature range: 32 to 140 Degrees Fahrenheit.
 - 2) Humidity: 20 to 90 percent, non-condensing.
 - e. Power Supply:
 - 1) DC: 12V -72V
 - 2) Max power consumption: 15W
 - 3) Provide Appliance Kit.

2.3 ACCESSORIES

- A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.
- B. Furnish accessories as specified in Section 40 68 00 - Control Systems: PCS Computer Equipment.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide installation and configuration for the new and existing managed Ethernet switches. Provide configuration of the Ethernet switch network for a complete, functioning plant control system:
 - 1. Refer to SCADA block diagrams for all new network connections.
 - 2. Provide configuration for all managed Ethernet switches and other components.
 - 3. Field switches in process control cabinets for the PLC and Equipment I/O and control network shall be configured as follows:
 - a. Enable SNMPv3 and configure on a separate network management subnet. Coordinate with OWNER for existing subnet and configuration requirements including passwords.
 - b. Enable IGMP Snooping
 - c. Configure ring settings for compatibility with existing network ring topology as required using manufacturer's recommended ring technology. Utilize RSTP for non-ring connections that are not terminated at single devices and enable PortFast for single device connections. Unused ports shall be configured with default settings

- to allow additional or replacement process control devices to be added to the network.
 - d. Change all default device username and passwords and provide OWNER with a listing of all non-default settings.
 - e. Configure TFTP for automatic backup of all configurations.
 - 4. SCADA and core network components, these are components not directly connected to process control or I/O devices but are used within the SCADA system:
 - a. Provide VLAN and Subnet segmentation of ports and define routes for proper operation but to limit traffic only to necessary communication.
 - b. Define access control lists to implicitly deny all traffic unless specific rules are entered to allow traffic. Work with the OWNER and equipment and software manufacturers to determine required TCP/UDP ports required for proper operation of equipment.
 - c. Configure TFTP for automatic backup of all configurations.
 - d. Change all default device username and passwords and provide OWNER with a listing of all non-default settings.
 - e. Enable SNMPv3 and configure on a separate network management subnet. Coordinate with OWNER for existing subnet and configuration requirements including passwords.
 - f. Enable IGMP Snooping.
 - g. Configure switch stacking and port aggregation as required for resiliency.
 - 5. The process floor managed Ethernet switches for the process control network shall be configured and programmed for rapid fail over protection.
 - 6. The enterprise level managed Ethernet switches shall be configured for a communication protocol that is compatible with the process control network's rapid fail over protocol.
- C. All racks shall be level and plumb.
- D. Install Velcro wrap on all cable bundles within the network rack/enclosure.
- E. All cables and equipment shall be installed in strict conformance with the manufacturer's recommendations:
 - 1. Cables shall be installed avoiding sharp bends.
 - 2. Install cable using lubricant designed for cable pulling.
 - 3. Cable ties or other cable supports shall be installed without crimping the LAN cables.
 - 4. Install LAN cables without splices.
 - 5. Installed bend radii shall not exceed 4 times the cable diameter.
 - 6. Terminated all pairs at the jack and the patch panel.
- F. Install cables a minimum of 40 inches away from electrical motors and transformers.
- G. Install cables a minimum of 12 inches away from fluorescent lighting.
- H. Individual pairs will be untwisted less than 1/2-inch at termination points.
- I. All cables and terminations shall be labeled with cable designations as specified

in Section 26 05 53 - Identification for Electrical Systems.

- J. Each data port shall be individually labeled with its patch panel/switch port ID:
 - 1. Labeling must be printed - no handwritten labels will be allowed.
- K. At the completion of the wiring installation, provide the following documentation:
 - 1. A plan-view of the premise(s) showing the jack numbering scheme.
 - 2. A printed certification report for the entire wiring installation showing compliance with all EIA/TIA specifications for data cable.
 - 3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.

3.2 ADJUSTING

- A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

3.3 CLEANING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.4 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. After completion of the cable system tests and before placing the system in operation, power up all devices installed on the LAN and verify communication between the devices.
- C. Verify that all equipment is operable on the network simultaneously. Confirm that all network device communications settings are properly configured.

+ + END OF SECTION + +

SECTION 40 66 63

CONTROL SYSTEMS: WIRELESS COMMUNICATIONS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Cellular communication system.
- B. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.2 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 - 1. CPM: Critical path method.
 - 2. EIRP: Effective isotropically radiated power.
 - 3. Fade margin: This is the amount of margin left to allow for the natural variations in radio performance, which will occur due to weather, air density, etc.
 - 4. FCC: Federal Communications Commission.
 - 5. ITS: Institute for Telecommunications Science.
 - 6. RF: Radio frequency.
 - 7. SIM: Subscriber identity module.

1.3 SYSTEM DESCRIPTION

- A. The cellular communication system will serve the following sites:
 - 1. Home Depot Pump Station.

1.4 SUBMITTALS

- A. Furnish submittals as specified in Sections 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Prepare and submit an agenda for 2 mandatory coordination meetings.
 - 1. First meeting held within 30 days of the contract award:
 - a. The purpose of the meeting is:
 - 1) For the Contractor to summarize their understanding of the Project.
 - 2) Discuss any proposed alternatives.
 - 3) Schedule access to Owner sites.
 - 4) Schedule the remaining coordination meeting.
 - 5) Request any additional information required from the Owner.
 - 6) Coordinate activating devices on Owner's private M2M network.
 - 2. Second meeting held after site visits to verify cellular service and antenna

mounting requirements have been completed and proposed equipment has been approved and purchased:

- a. The purpose of this meeting is:
 - 1) For the Contractor to present the findings of the site survey to the Owner.
 - 2) To discuss any issues with cellular service or antenna mounting constraints.
 - 3) Activate devices and test communication.
- C. Submit for each LTE cellular communication system:
 1. Product data for the following:
 - a. Cellular modem.
 - b. Antenna.
 - c. Cable between cellular modem and antenna.
 - d. All other related accessories.
 2. Certificate for approval of cellular modem by the suggested cellular network service provider/carrier.
 3. Antenna gain calculation:
 - a. Calculate gain of Omni directional antenna based on antenna mounting height and distance to be covered by the cellular system for the corresponding application.
 4. Installation instructions for each component indicated above.
 5. Type of LTE service that will be provided.
 - a. Provide setup/configuration information for the LTE service.
 6. Block diagram showing the location and communication of each component of the cellular communication system.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Procedure for verifying the communications between sites shall be as follows:
 1. Field verify cellular service prior to installation.
- C. After installation, verify through the use of internal modem diagnostics, that the installed equipment conforms to reliability benchmark published by the manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.8 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.9 MAINTENANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Furnish all parts, materials, fluids, etc., necessary for maintenance and calibration purposes for 1 year:
 - 1. Deliver all supplies before Substantial Completion

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Wireless cellular communication system:
 - 1. One of the following or equal:
 - a. Sierra Wireless, RV55, P/N RV55_1104303-ROUTER LTE-A PRO NA DC CABLE

2.2 MANUFACTURED UNITS

- A. Wireless cellular communication system:
 - 1. General:
 - a. The wireless cellular system comprises the following:
 - 1) Cellular modem with dual SIM card slots.
 - 2) Omni antenna.
 - 3) Software/Documentation and other accessories as specified in the Accessories article.
 - b. Performance requirements:
 - 1) Cellular modem and omni antenna to operate in quad-band range: 850/900/1,800/1,900 MHz.
 - 2) Operating temperature range: -25 to 60 degrees Celsius.
 - 2. Cellular modem:
 - a. LTE enabled cellular modem.
 - b. Provide 1 SIM card for each cellular modem on the Owner's cellular network.
 - c. Communication with equipment to be monitored:
 - 1) Ethernet.
 - d. Communication Ports:
 - 1) Ethernet, RJ-45
 - 2) Serial RS-232, DB9
 - e. Power supply: 24 VDC.
 - f. LED indication for status and alarm.
 - g. Mounting: DIN rail.
 - h. Enclosure: IEC IP20.
 - i. Antenna Connection: 3 SMA connectors (primary, diversity, gps).
 - j. Network and Routing:
 - 1) Network Address Translation.

- 2) Port Forwarding.
 - 3) IPsec and OpenVPN with up to 5 tunnels.
- k. Remote Authentication: LDAP.
- l. Port, IP, and MAC Filtering.
- m. Network Management: SNMP.
- n. Discrete I/O: 1 input, minimum.
- 3. Antenna:
 - a. Omni-directional type antenna.
 - b. Antenna gain: As described in the Submittals article under "Antenna Gain Calculation."
 - c. Surface mounting.
- 4. Cable between cellular modem and antenna: Manufacturer's standard.
- 5. Software and documentation: Manufacturer's standard.

2.3 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.2 ADJUSTING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Orient and locate antennas as required for maximum receive strength signal intensity (RSSI) during startup.

+ + END OF SECTION + +

SECTION 40 67 00

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Design, fabrication and assembly of all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:
 - a. Custom built instrumentation and control panels, including all enclosures for hand stations controllers, low voltage power distribution and marshalling panels.
 - b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCPs) and chemical feed panels.
 - c. Control components.
 - d. Control panel installation.
- B. Provide all control panels identified in Contract Documents.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
 - 2. 802.3af - Standard for Information Technology Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
 - 3. 802.3at - Standard for Information Technology -- Local and Metropolitan area networks -- Specific requirements -- Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements.
- C. International Electrotechnical Commission (IEC):
 - 1. 61643-11 - Low-Voltage Surge Protective Devices - Part 11: Surge Protective Devices Connected to Low-Voltage Power Systems - Requirements and test methods.
 - 2. 61643-21 - Low-Voltage Surge Protective Devices - Part 21: Surge Protective Devices Connected to Telecommunications and Signaling Networks - Performance Requirements and Testing Methods.

- D. Underwriters Laboratories Inc. (UL):

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1. 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits.
2. 508 - Standard for Industrial Control Equipment.
3. 508A - Standard for Industrial Control Panel.
4. 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
5. 913 - Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations.
6. 1283 - Standard for Electromagnetic Interference Filters.
7. 1449 - Standard for Surge Protective Devices.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 1. The term "panel" in this Section is interchangeable with the term "enclosure."

1.4 SUBMITTALS

- A. Provide submittals as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide a control panel hardware submittal for each control panel and enclosure being provided on this project, including but not limited to:
 1. Product data:
 - a. Enclosure construction details and NEMA type.
 - b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.
 2. Shop drawings:
 - a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
 - 1) Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.
 - b. Complete nameplate engraving schedule.
 - c. Structural details of fabricated panels.
 3. Calculations:
 - a. Provide installation details based on calculated shear and tension forces:
 - 1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.
 - b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:
 - 1) Weight including panel internal components.
 - 2) Seismic forces and overturning moments.

- 3) Shear and tension forces in connections.
- c. Cooling calculations, including but not limited to:
 - 1) Highest expected ambient temperature for the enclosure's location.
 - 2) Internal heat load.
 - 3) Exposure to direct sunlight.
 - 4) Dimensions of the enclosure in inches.
 - 5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
 1. Provide all components and equipment with UL 508 listing.
 2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL 508A labeling:
 - a. Non-listed, complex, and unique equipment may be evaluated and approved by a third-party testing agency, with prior approval by the Owner. Provide report documenting the testing standard, specification, method of testing, and that the equipment and materials meet appropriate designated standards or have been tested and found suitable for use in a specified manner.
 3. Provide fuses for all equipment that is not UL or UR listed.
 4. Install all intrinsically safe circuits and equipment in accordance with UL698A.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Project environmental conditions as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
 1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation.

1.8 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 2 – PRODUCTS

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2.1 MANUFACTURERS

- A. As listed below in the individual component paragraphs.
- B. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

2.2 SYSTEM DESCRIPTION

- A. Panel dimensions:
 - 1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer's non-certified information. It is the responsibility of the Contractor or manufacturer to design and size all panels:
 - a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.
 - b. Panel sizes that substantially deviate (within 3 inches in any dimension) from the sizes indicated on the Drawings must be approved by the Engineer.
 - c. Maximum panel depth: 30 inches, unless otherwise indicated.
- B. Pump Station Control Panel Relay Logic:
 - 1. Primary mode of pump control shall be from the programmable logic controller as stated in section 40 61 96 Process Control Descriptions. Backup mode of pump control based on floats via relay logic shall be built in the control panel. Provide relay circuitry such that the dry contacts to the pump starter cabinets for the three main pump start/stop command shall be driven from either the PLC (Primary mode) or the backup float system.
 - 2. Normally, the main pumps shall be controlled from the PLC based on level in the wet well. Backup mode of pump operation shall only be initiated in the event of a PLC failure or the unavailability of both the level instruments while the main pumps are still available.
 - 3. Relay logic shall be set such that, if the above stated conditions are met and the level in the wet well reaches the Pumps Start Float (LS1-1001), all three main pumps shall run. However, to avoid load fluctuations, adjustable delay timers shall be provided in the circuitry to stagger the pump start command, such that only one pump comes online at a time.
 - 4. All pumps shall stop when the level gets below the Low-level float (LSL-1001).
 - 5. When the backup mode is active, front panel indicating lights shall be triggered for float system active and pump run statuses.
 - 6. Once the backup mode triggering conditions are no longer active, after an adjustable time delay, the system shall be released to primary mode of control.

2.3 EXISTING PRODUCTS

- A. Provide labor and materials for complete modifications to existing panels as required.

- B. Field cut and refinish existing panel faces to original condition to accommodate installation of new instruments, removal of existing instruments, and fitting of blanks to suit new layouts. New instrument supports shall be provided as required for complete installation.

2.4 MATERIALS

- A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
1. Enclosures shall have the following properties:
 - a. NEMA Type 1: Steel.
 - b. NEMA Type 4: Steel with gasketed door, raintight.
 - c. NEMA Type 4X: Type 316 stainless steel (unless Type 304 is indicated on the Drawings).
 - d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.
 - e. NEMA Type 12: Steel with gasketed door, dust tight.
 - f. NEMA Type 7: Cast aluminum.
 - g. Rittal.
 - h. nVent/Hoffman.
 - i. Saginaw Control & Engineering.
- B. Bolting material:
1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
 2. Carriage bolts for attaching end plates.
 3. All other bolted joints shall have S.A.E. standard lock washers.

2.5 MANUFACTURED UNITS

- A. Panels/enclosures:
1. Manufacturers: One of the following or equal:
 2. Panel assembly:
 - a. General guidelines for panel fabrication include:
 - 1) Continuous welds ground smooth.
 - 2) Exposed surfaces free of burrs and sharp edges.
 - 3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.
 - b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)

Wall-mounted up to 48	14	14
Up to 57	12	12
57 - 69	12	10
69 - 82	12, except 10 on back	10
82 or more	10	10

- 1) Use heavier sheet metal to meet seismic requirements at the project site or when required due to equipment requirements.
- c. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.
- d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.
- e. Door construction:
 - 1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
 - 2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
 - 3) Heavy-gauge stainless steel hinges.
 - 4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
 - 5) Gasket installed to seal against roll lip on the enclosure opening.
- f. Latches:
 - 1) For panels, provide each door with a 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
 - a) Provide padlock for each enclosure with padlock provisions.
 - 2) Include an oil tight key-locking, 3-point latching mechanism on each door:
 - a) Provide 2 keys per panel.
 - b) All locks keyed alike.
- g. Panel cut-outs:
 - 1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
 - 2) Allow a minimum of 3-inch envelope around all displays, controllers, and monitors.
 - 3) Reinforce around cut-outs with steel angles or flat bars for the following:
 - a) Large panel cutouts; for example, openings for local operator interfaces.
 - b) Pilot device groupings, where the removed metal exceeds

50 percent of the available metal.

3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
 - a. Minimum 14-gauge, Type 304 stainless steel.
 - b. Captive stainless-steel cover screws threaded into sealed wells.
 - c. Inside finish: White polyester powder coating.
 - d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.
4. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
 - a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
 - b. Door hardware: Stainless steel.
 - c. Provide factory installed rain canopy and sun shield for all enclosures with operator interface panels.
 - d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.

B. Mission RTU Panel:

1. Provide Mission Control MyDro 150 packaged system for integration with diesel engine pump as indicated in Contract Drawings.
2. Include provisions to engage manufacturer field services to configure, test, and startup the system. The Mission RTU unit shall be interfaced into OWNER's existing Mission Web server.
3. Major Features:
 - a. Input/Output : Minimum of 8 Digital Inputs, 2 4-20mA analog inputs and 3 remotely controllable relay outputs. Configure pump information, run times and starts summarized.
 - b. Main Power: 120VAC
 - c. Backup Power: Battery powered. Provide a 35Ah battery to support 72 hours of backup power.
 - d. Panel: Large NEMA 4X enclosure to fit the battery size.
 - e. Communication: Provide cellular radio and omnidirectional antenna.
 - f. Include service and one year warranty packages.

C. Arrangement of components:

1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.
3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
4. All control panel mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

5. For enclosures containing PLCs or other heat sensitive electronics that require clean uninterruptable power, locate the UPS outside the control panel enclosure and provide separate incoming power terminal blocks for UPS backed up control power and auxiliary power (for lighting, utility power outlets, heating and cooling, etc.)

D. Overcurrent protection:

1. Main overcurrent device:
 - a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:
 - 1) Door-mounted disconnect handles are not acceptable.
 - 2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
 - 3) Provide means to defeat the interlock.
 - 4) Lockable in the off position.
 - b. Control panels supplied with 120 VAC:
 - 1) Provide an internal breaker with the line side terminals covered by a barrier.
 - 2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
2. Provide circuit breakers as specified in Section 26 27 26.13 - Low Voltage Molded Case Circuit Breakers.
3. Selection and ratings of protective devices:
 - a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
 - b. Voltage rating: Not less than the voltage of the application.
 - c. Select current rating and trip characteristics to be suitable for:
 - 1) Maximum normal operating current.
 - 2) Inrush characteristics.
 - 3) Coordination of the protective devices to each other and to the source breaker feeding the panel.
4. Provide a separate protective device for each powered electrical device:
 - a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
 - b. An individual fuse for each PLC discrete output. Provide with individual re- settable fuse indication external of the I/O card:
 - 1) Size external fuse to open before any I/O-card-mounted fuses.
 - c. Individual discrete inputs shall use a 1/2-ampere fuse.
 - 1) Control loops shall use a 5-ampere fuse.
 - d. Install protective devices on the back-mounting panel and identify by a service nameplate in accordance with the wiring diagrams.
5. Fuses for 4-to- 20 milliamperes signals:
 - a. Provide durable, readily visible label for each fuse, clearly indicating

the correct type, size, and ratings of replacement fuse:

- 1) Label shall not cover or interfere with equipment manufacturer's instructions.
 - b. An individual 1/2-ampere fuse for each 4-to-20 milliamperes analog loop powered from the control panel.
 - c. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
 - d. Manufacturers: One of the following or equal:
 - 1) Ferraz Shawmut.
 - 2) Littelfuse.
 - 3) Bussmann.
6. Fuse holders:
- a. Modular type:
 - 1) DIN rail mounting on 35-millimeter rail.
 - 2) Touch-safe design: All connection terminals to be protected against accidental touch.
 - 3) Incorporates blown-fuse indicator.
 - 4) Plug-in style fuse terminals and fuse plugs are not acceptable.
 - b. Provide nameplate identifying each fuse:
 - 1) As specified in Section 26 05 53 - Identification for Electrical Systems.
 - c. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, UT4-HESI Series.
 - 2) Allen-Bradley, 1492-FB Series B.
7. Control circuit breakers:
- a. DIN rail mounting on 35-millimeter rail.
 - b. Manual OPEN-CLOSE toggle switch.
 - c. Rated for 250 VAC.
 - d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
 - e. Current ratings: As required for the application.
 - f. Provide nameplate identifying each circuit breaker:
 - 1) As specified in Section 26 05 53 - Identification for Electrical Systems.
 - g. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, TMC Series.
 - 2) Allen-Bradley.
 - 3) Weidmuller.

E. Conductors and cables:

1. Provide as specified below unless otherwise noted on the drawings.
2. Power and control wiring:
 - a. Materials: Stranded, soft annealed copper.
 - b. Insulation: 600 volts type MTW.
 - c. Minimum sizes:
 - 1) Primary power distribution: 12 AWG.
 - 2) Secondary power distribution: 14 AWG.
 - 3) Control: 16 AWG.
 - d. Color:
 - 1) AC power (line and load): Black.

- 2) AC power (neutral): White.
 - 3) AC control: Red.
 - 4) AC control: Orange for foreign voltages.
 - 5) DC power and control (ungrounded): Blue.
 - 6) DC power and control (grounded): White with Blue stripe.
 - 7) Ground: Green.
3. Signal cables:
- a. Materials: Stranded, soft annealed copper.
 - b. Insulation: 600 volts, PVC outer jacket.
 - c. Minimum size: 18 AWG paired triad.
 - d. Overall aluminum shield (tape).
 - e. Copper drain wire.
 - f. Color:
 - 1) 2-Conductor:
 - a) Positive (+): Black.
 - b) Negative (-): White and red.
 - 2) 3-Conductor:
 - a) Positive (+): Black.
 - b) Negative (-): Red.
 - c) Signal: White.
 - g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

F. Conductor identification:

1. Identify each conductor and cable with unique wire numbers as specified in Section 26 05 53 - Identification for Electrical Systems.
2. Readily identified without twisting the conductor.

G. General wiring requirements:

1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
2. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.
3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
5. Provide power surge protection for all control panels.
6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
7. Provide non-metallic ducts for routing and organization of conductors and cables:
 - a. Provide wiring separation plan.
 - b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
 - c. Provide separate ducts for signal and low-voltage wiring from power and 120-VAC control wiring:
 - 1) 120 VAC: Grey colored ducts.

- 2) 24 VDC: White colored ducts.
 - 8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
 - a. Screw-on cable tie mounts.
 - b. Hammer-on cable-tie mounting clips.
 - c. Fingers of the nonmetallic duct.
 - 9. Wire ties:
 - a. No wire ties inside wire duct.
 - b. Use Panduit Cable tie installation tool, with tension control/cutoff.
 - c. Verify cut ends are cut flush filed smooth after installed.
 - 10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
 - 11. Support panel conductors where necessary to keep them in place.
 - 12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
 - 13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
 - a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
 - 14. The control panel shall be the source of power for all 120-VAC devices interconnected with the control panel including, but not limited to:
 - a. Solenoid valves.
 - b. Instruments both mounted in the control panel and remotely connected to the control panel.
- H. Provide power circuits for all Contractor and Vendor-furnished PLC cabinets in accordance with the PLC and Instrument Power wiring diagrams Indicated on the Drawings or as specified.

2.6 COMPONENTS

- A. Thermal management:
- 1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range as specified in Section 1.7 40 60 00 - Common Work Results for Process Control and Instrumentation.
 - 2. Air conditioner:
 - a. Provide solid-state cabinet coolers or air conditioning units on panels indicated in Contract drawings, containing electronic components such as local operator interfaces, panel instruments, programmable logic controllers, or remote I/O.
 - b. Provide filters on intake and exhaust openings.
 - c. Increase panel sizes as needed to accommodate cooling units.
 - d. Enclosure rating: NEMA Type 4X.
 - e. Closed-loop design.
 - f. Power supply: 120 VAC.
 - g. Manufacturers: The following or equal:
 - 1) Kooltronic, GuardianDP Series.
 - 2) ICEcube, Blade series or IECEx/ATEX for Zone 1 & 2.

- 3) Hoffmann Thermoelectric Unit
3. Heating:
 - a. Provide all panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:
 - 1) The panel is not supplied with 120 VAC power.
 - 2) There are no electronics or moisture-sensitive devices in the enclosure.
 - 3) The panel is smaller than 38 inches high.
4. Heat exchanger:
 - a. Closed-loop design ensuring separation of ambient air and clean air inside the cabinet.
 - b. Filterless design to facilitate easy cleaning of the core.
 - c. Mounting: As indicated on the Drawings.
 - d. Manufacturers: The following or equal:
 - 1) Noren, CC Series.
 - 2) ICEcube, Blade series.
5. Enclosure temperature switch:
 - a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
 - b. Sensor and electronic enclosure.
 - c. Accuracy: Within 2 degrees Fahrenheit.
 - d. Single contact:
 - 1) Manufacturers: One of the following or equal:
 - a) nVent/Hoffman ATEMNC.
 - b) Pfannenberger FLZ.
 - e. Dual contact:
 - 1) Manufacturers: The following or equal:
 - c) nVent/Hoffman ADLTEMP.
6. Enclosure Temperature Transmitter:
 - a. Provide for enclosures having ControlLogix PLCs and where indicated on the drawings.
 - b. Temperature transmitter with 1K OHM platinum TCR.
 - c. Enclosure: NEMA 1 plastic
 - d. Output: 4-20mA, loop powered
 - e. Temperature Range: 20 to 120 degrees F.
 - f. Manufacturer:
 - 1) Kele, ST-T91E-XR1
7. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
 - a. Provide as indicated on the Drawings or as specified.
8. Fan ventilation:
 - a. Provide nVent/Hoffman fan speed control:
 - 1) Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.
 - 2) Provide finger-guard kit.
 - 3) Filter kit with 2 spare filters for each intake fan.
 - 4) Provide bezel and gasket kit.
 - 5) Provide fan shroud.

- 6) Automatically adjust fan speed depending on remote temperature sensor input.
- 7) 120 VAC, 60 hertz.
- 8) NEMA Type 5-15R cord connections.

B. Pilot devices:

1. General:

- a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
- b. Size:
 - 1) 30.5 millimeters.
- c. Heavy duty.
- d. Pushbuttons:
 - 1) Contacts rated:
 - a) NEMA Type A600.
 - 2) Furnish 1 spare normally open contact and normally closed contact with each switch.
- e. Selector switches:
 - 1) Contacts rated:
 - a) NEMA Type A600.
 - b) Knob type.
 - 2) Furnish 1 spare normally open contact and normally closed contact with each switch.
 - 3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
- f. Pilot lights:
 - 1) Type:
 - a) LED for interior installations.
 - 2) Push to test.
 - 3) Lamp color:
 - a) On/Running/Start: Red.
 - b) Off/Stop: Green.
 - c) Power: White.
 - d) Alarm: Amber.
 - e) Status or normal condition: White.
 - f) Opened: Red.
 - g) Closed: Green.
 - h) Failure: Red.

2. Indoor and outdoor areas:

- a. NEMA Type 4/13.
- b. Manufacturers: Provide the following:
 - 1) Siemens, Class 50.

3. Corrosive areas:

- a. NEMA Type 4X.
- b. Corrosion resistant.
- c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.
- d. Manufacturers: Provide the following:
 - 1) Siemens, Class 52.

4. Hazardous (Classified) Areas/Class I Division 2:
 - a. NEMA Type 4X.
 - b. Corrosion resistant.
 - c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc:
 - 1) All contacts contained within a hermetically sealed chamber:
 - a) Pushbuttons.
 - b) Selector switches.
 - c) Push-to-test contacts on pilot lights.
 - 2) UL listed and labeled for Class I Division 2 areas.
 - d. Manufacturers: Provide the following:
 - 1) Siemens, Class 51.
- C. Signal isolators and converters:
1. Furnish signal isolators that provide complete isolation of input, output, and power input:
 - a. Minimum isolation level: 1.0 kilovolts AC/50 hertz for at least 1 minute.
 - b. Adjustable span and zero.
 - c. Accuracy: Within 1.0 percent of span.
 - d. Ambient temperature range: -4 degrees to 149 degrees Fahrenheit.
 2. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, Mini Analog Pro.
 - b. Acromag, 1500, 600T, 800T, Flat Pack, or ACR Series.
 - c. Weidmuller.
- D. Relays:
1. General:
 - a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
 - b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
 - c. For plug in type relays, provide a relay base from the same manufacturer as the relay manufacturer.
 2. General purpose:
 - a. Magnetic control relays.
 - b. NEMA ratings:
 - 1) 300 volts.
 - 2) 10 Amps thermal continuous test current.
 - 3) 60 Amps make.
 - 4) 6 Amps break.
 - c. Plug-in type.
 - d. LED indication for energization status.
 - e. Coil voltages: As required for the application.
 - f. Minimum poles: DPDT.
 - g. Touch-safe design: All connection terminals to be protected against accidental touch.
 - h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.

- i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
 - j. Relays with screw-type socket terminals.
 - k. Provide additional (slave/interposing) relays when the following occurs:
 - 1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
 - 2) Higher contact rating is required in order to interface with starter circuits or other equipment.
 - l. DIN rail mounting on 35-millimeter rail.
 - m. Ice-cube-type relays with retainer clips to secure relay in socket.
 - n. Integrated label holder for device labeling.
 - o. Manufacturers: One of the following or equal:
 - 1) IDEC: R* Series (* = H, J, R, S, U).
 - 2) Allen-Bradley: Type 700 HC.
 - 3) Square D: Type K.
3. Terminal block relays:
- a. Magnetic control relays.
 - b. For use as an interposing relay for PLC based discrete I/O signals.
 - c. NEMA ratings:
 - 1) 250 volts.
 - 2) 6 Amps continuous.
 - 3) 1,500 volt-amperes make.
 - d. Plug-in type.
 - e. LED indication for energization status.
 - f. Coil voltages: As required for the application.
 - g. Minimum poles: SPDT.
 - h. Touch-safe design: All connection terminals to be protected against accidental touch.
 - i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
 - j. Relays with screw-type socket terminals.
 - k. DIN rail mounting on 35-millimeter rail.
 - l. Integrated label holder for device labeling.
 - m. Manufacturer: One of the following or equal:
 - 1) Phoenix Contact PLC Series.
 - 2) Weidmuller.
 - 3) Allen-Bradley Type 700 HL TBR Series.
4. Latching:
- a. Magnetic-latching control relays.
 - b. NEMA ratings:
 - 1) 300 volts.
 - 2) 5 Amps continuous.
 - 3) 360 volt-amperes make.
 - 4) 320 volt-amperes break.
 - c. Plug-in type.
 - d. DIN rail mounting on 35-millimeter rail.
 - e. Coil voltage: As required for the application.
 - f. Minimum poles: 2 PDT; as required for the application. Plus 1 spare

- pole.
- g. Touch-safe design: All connection terminals to be protected against accidental touch.
- h. Clear cover for visual inspection.
- i. Provide retainer clip to secure relay in socket.
- j. Manufacturers: One of the following or equal:
 - 1) Square D, 8501, Type K.
 - 2) IDEC, RR2KP Series.
- 5. Time delay:
 - a. Provide time-delay relays to control contact transition time.
 - b. Contact rating:
 - 1) 240 volts.
 - 2) 10 Amps continuous.
 - 3) 3,600 volt-amperes make.
 - 4) 360 volt-amperes break.
 - c. Coil voltage: As required for the application.
 - d. Provide pneumatic or electronic type with on-delay, off-delay, and on/off- delay:
 - 1) For off-delay, use true power-off time-delay relays. Where the required timing range exceeds capability of the off-delay relay use, signal off-delay where power loss will not cause undesirable operation or pneumatic time-delay relays.
 - e. Minimum poles: 2 PDT.
 - f. Units include adjustable dial with graduated scale covering the time range in each case.
 - g. Minimum timing range: 0.1 seconds to 10 minutes, or as required for the application.
 - h. Manufacturers: One of the following or equal:
 - 1) IDEC, RTE Series.
 - 2) Tyco Electronics, Agastat 7000 Series (pneumatic).
 - 3) Allen-Bradley, Type 700-HR.

E. Terminal blocks:

- 1. DIN rail mounting on 35-millimeter rail.
- 2. Rated for 15 amperes at 600 volts.
- 3. Screw terminal type.
- 4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
- 5. Finger-safe protection for all terminals for conductors.
- 6. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 degrees to 221 degrees Fahrenheit.
- 7. Terminals: Plainly identified to correspond with markings on the diagrams:
 - a. Permanent machine-printed terminal identification.
- 8. Disconnect-type field signal conductor terminals with socket/screw for testing.
- 9. Identify terminals suitable for use with more than 1 conductor.
- 10. Position:

- a. So that the internal and external wiring does not cross.
 - b. To provide unobstructed access to the terminals and their conductors.
 - 11. Provide minimum 25-percent spare terminals.
 - 12. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, UT4 Series.
 - b. Weidmuller.
 - c. Allen-Bradley, 1492 Series.
- F. DIN rail grounding:
- 1. Grounding terminal blocks used exclusively for bonding each DIN rail section to panel grounding busbar shall:
 - a. Mount to DIN rail via grounding foot with mounting screw.
 - b. Connect to the panel grounding busbar shall be via a green insulated conductor sized in accordance with NEC.
 - c. Not be used for grounding signal cable shields.
 - 2. Screw terminal type.
 - 3. DIN rail mounting on 35-millimeter rail.
 - 4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
 - 5. Finger-safe protection for all terminals for conductors.
 - 6. Terminals: Plainly identified to correspond with markings on the diagrams:
 - a. Permanent machine-printed terminal identification.
 - 7. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, USKLG Series.
 - b. Allen-Bradley, 1492-JG Series.
 - c. Weidmuller.
- G. Wire duct:
- 1. Provide flame retardant plastic wiring duct, slotted with dust cover.
 - 2. Type:
 - a. Wide slot.
 - b. Narrow slot.
 - c. Round hole.
 - 3. Manufacturers: The following or equal:
 - a. Panduit.
 - b. Phoenix Contact.
 - c. Thomas & Betts.
- H. DIN rail:
- 1. Perforated steel.
 - 2. 35 mm width.
 - 3. 15 mm deep.
 - 4. Provide 2-inch offset using one of the following:
 - a. Offset brackets.
 - b. Preformed standoff DIN Rail Channel.

I. Surge protection devices (SPD):

1. 120 VAC control panel power SPD:
 - a. Provide SPD for panel 120 VAC power entrances:
 - 1) Non-faulting and non-interrupting design.
 - 2) Provide line to neutral and neutral to ground surge protection.
 - b. Provide surge protection at secondary of main circuit breaker:
 - 1) Surge protection is not required for 120 VAC circuits that are only used for panel lights and receptacles.
 - 2) For panels receiving power at 480 VAC, provide surge protection on the 120 VAC control power transformer secondary.
 - c. DIN rail mounting.
 - d. Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
 - 1) Gastight connections.
 - 2) Visual status indication of MOV status on the input and output circuits.
 - 3) Dry contact rated for remote status indication.
 - e. Approvals:
 - 1) Tested in accordance with IEC 61643-11.
 - 2) Tested in accordance with UL 1283.
 - 3) Tested in accordance with UL 1449.
 - 4) Surge protection minimum requirements: Withstand a minimum
 - 5) 10-kA test current of an 8/20 μ s waveform in accordance with IEEE C62.41.1 Category C Area.
 - f. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, Type SFP Filter.
 - 2) ASCO, Model 277.
2. 24 VDC control panel power SPD:
 - a. Provide SPD for 24VDC power circuits.
 - b. Provide surge protection at DC power supply output.
 - c. DIN rail mounting.
 - d. Attach wiring to the SPD by means of a screw-type cable clamping terminal block:
 - 1) Optical status indicator.
 - 2) Dry contact rated for remote status indication.
 - e. Approvals:
 - 1) Tested in accordance with IEC 61643-11.
 - f. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, Plugtrab PLT-SEC-T3-24-FM-UT.
3. Panel mounted control, signal, and data line SPD:
 - a. General:
 - 1) This section applies to SPD located in a control panel, field panel, network junction box, or marshalling panel.
 - 2) Approvals:
 - a) Tested in accordance with IEC 61643-21.
 - b) Tested in accordance with UL 497B.
 - 3) SPD shall consist of 2 parts:
 - a) Base module:

- (1) DIN rail mounting.
 - (a) Grounded to DIN rail via mounting rail foot.
 - b) Plug protection module:
 - (1) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
 - 4) Provide indirect shield ground style SPD unless otherwise noted.
 - 5) Provide ability to locally identify and indicate SPD health.
 - 6) SPD shall be provided with controller module with dry contact for remote status monitoring of SPD device health.
 - 7) SPD modules shall be compatible with signal, communication bus type, data type, or control power being protected.
 - 8) Provide dedicated SPD for each signal, communication bus type, or data line being protected.
 - b. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, Plugtrab PT-IQ Series.
 - 2) Weidmuller.
- 4. Copper Ethernet SPD:
 - a. Protects network equipment from lightning or other surge events.
 - b. Suitable for Gigabit networks.
 - c. Compatible with shielded Cat 6 cabling with shielded RJ-45 ports.
 - d. Compliant with PoE standards IEEE 802.3af and 802.3at.
 - e. Nominal discharge surge current: 10 kA.
 - f. Approvals:
 - 1) Tested in accordance with IEC 61643-21.
 - 2) Tested in accordance with UL 497B.
 - g. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, DT-LAN-CAT6+.
 - 2) Weidmuller, VDATA CAT6.
- 5. Field device mounted SPD:
 - a. Conduit entry mounting.
 - 1) Provide parallel or through wiring configurations as required by the application.
 - a) Use parallel wiring configuration if there is an available cable gland at the device.
 - b) Use through wiring configuration if there is no available cable gland at the device.
 - 2) Provide Screw connections compatible with field device.
 - b. NEMA 4X stainless steel material housing.
 - c. Approvals:
 - 1) Tested in accordance with IEC 61643-21.
 - d. 4-wire field device:
 - 1) Module shall provide simultaneous protection of signal cable, communication bus, or data line, and power supply line.
 - a) Maximum continuous voltage:
 - (1) DC:
 - (a) Signal: 32 VDC.
 - (b) Power supply: 255 VDC.
 - (2) AC:

- (a) Signal: 22.6 VAC.
 - (b) Power supply: 255 VAC.
 - 2) Manufacturers: The following, engineer knows of no equal:
 - a) Endress+Hauser, HAW569-CB2C.
 - e. 2-wire or 3-wire field device:
 - 1) Module shall provide protection for the signal cable, communication bus or data line.
 - 2) Manufacturers: One of the following or equal:
 - a) Phoenix Contact, Surgetrab S-PT Series.
 - b) Emerson/Edco, SS64 or SS65 Series.
- J. Power supplies:
- 1. Design power supply system so that either the primary or backup supply can be removed, repaired or replaced, and returned to service without disrupting the system operation.
 - 2. Convert 120 VAC to 24-volt DC or other DC voltages required or as required for the application.
 - 3. Provide redundant backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
 - 4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure in either a 1+1 or N+1 configuration as required:
 - a. Provide automatic switchover upon module failure.
 - b. Alarm contacts monitored by the PLC.
 - 5. Provide protective isolation between power supply units by means of built in redundancy. Power supplies with built in redundancy must actively isolate each power supply and be designed as such.
 - 6. Sized to provide 40-percent excess rated capacity.
 - 7. UL 508C listed to allow full-rated output without de-rating.
 - 8. Provide fuse or short-circuit protection.
 - 9. Provide a minimum of 1 set of dry contacts for each power supply configured to change state on failure for monitoring and signaling purposes.
 - 10. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change.
 - 11. Operating temperature range: 32 degrees to 140 degrees Fahrenheit.
 - 12. Touch-safe design: All connection terminals to be protected against accidental touch.
 - 13. DIN rail mounting on 35-millimeter rail:
 - a. Mount the power supply in the proper orientation as recommended by the manufacturer to ensure adequate thermal dispersion without derating the power supply.
 - 14. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
 - 15. Manufacturers: One of the following or equal:
 - a. Fully redundant:
 - 1) Phoenix Contact, Quint Power Supply with SFB and integrated decoupling MOSFET technology.
 - a) Phoenix Contact, Quint.
 - 2) Weidmuller, ProTop

K. Limit switches:

1. NEMA Type 4X.
2. AC contact rating 120 volts, 10 A.
3. DC contact rating 125 volts, 0.4 A.
4. Provide robust actuation mechanism not prone to degradation.
5. Provide complete actuator mechanism with all required hardware.
6. Allows for contact opening even during contact weld condition.
7. UL approved.
8. Operating temperature range: 0 degrees to 230 degrees Fahrenheit).
9. Manufacturers: One of the following or equal:
 - a. Allen-Bradley, 802 Series.
 - b. Honeywell, HDLS Series.
 - c. Square D.

L. Horns and Beacons:

1. Beacons/horn combination units:
 - a. Manufacturers: The following or equal:
 - 1) Edwards, Multi-Status LED 108i with tone module.
 - b. LED Colors: Red, Green, and Amber.
 - c. Power: 120VAC.
 - d. Provide accessories such as pipe mount flange, pipe extensions, corner mount brackets, or wall mount brackets as needed.
 - e. Horn rated 80 dB minimum at 10 feet.
2. Dedicated beacon unit:
 - a. Manufacturers: One of the following or equal:
 - 1) Federal Signal Corp., Starfire Series.
 - 2) Allen-Bradley, 855 B *-* 10 Series.
 - 3) Edwards, 102 Series.
3. Dedicated horn unit:
 - a. Electromechanical:
 - 1) Manufacturers: One of the following or equal:
 - a) Federal Signal, 350 or 31X Series.
 - b) Edwards, 878EX or 879EX Series.
 - b. Electronic:
 - 1) Manufacturers: One of the following or equal:
 - a) Federal Signal, 300GCX or 300X Series.
 - b) Allen-Bradley, 855H or 855XH Series.
 - c) Edwards, 5530M or 5533MD Series.
 - c. Rated for 80 dB minimum at 10 feet.

M. Uninterruptible Power Supply (UPS):

1. General:
 - a. Provide Uninterruptible Power Supply (UPS) unit to meet power requirements in all control panels.
 - b. UPS shall be furnished to provide a reliable source of uninterruptible power with no break in AC output power during a complete or partial interruption of incoming line power. UPS shall include visual alarms. UPS shall be UL listed.
 - c. UPS shall be rated to provide uninterrupted conditioned power, fully

loaded conditions for 20 mins.

2. Description: Online dual-track power conditioner and true (0 mS transfer time) uninterruptible power supply providing isolation, line regulation, and conditioning, using sealed maintenance-free batteries and switch-mode power supply for uninterrupted power with 0.5 to 0.7 power factor and 2.7 to 3.5 crest factor.
3. Required Features:
 - a. Lighting and Surge Protection: Inherent 2000: One spike attenuation.
 - b. Regulation: One to three percent load regulation with less than 2PF effective coupling capacitance for the line to load.
 - c. Output Waveform: Computer grade sine wave with three percent maximum single harmonic and five percent maximum total harmonic distortion (THD).
 - d. Output Frequency: 60 Hz $\pm$ 0.5 Hz.
 - e. Operating Temperature: 1°C to 40°C.
 - f. Relative Humidity: 5 to 90% non-condensing.
 - g. Dry contact output (For 750 VA and above): Provide a minimum of three dry contact outputs configured for "UPS Fault", "UPS on Battery", and "UPS Battery Low".
 - h. Input Protection: Independent battery charger fuse and DC fuses.
 - i. Output Protection: Inherently current limited Ferro-resonant transformer.
 - j. Battery Charger: Two-step charger, 8 A, and 2 A.
 - k. AC Input: 120 VAC, 60Hz, single phase, +15 percent, -20 percent.
 - l. AC Output: 120 VAC, 60Hz, single phase, +3 percent, -3 percent.
 - m. Provide an external manual bypass switch; break-before-make type in each of the control panels.
4. Product and Manufacturers: Provide one of the following:
 - a. APC
 - b. Or Equal

2.7 ACCESSORIES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.
- C. Provide 15-inch floor stands or legs where needed or as indicated on the Drawings.
- D. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of

supporting a laptop computer.

- E. Provide nameplate to each panel as indicated on the Drawings:
 - 1. Provide as specified in Section 26 05 53 - Identification for Electrical Systems on all internal and external instruments and devices.
 - 2. Provide a nameplate with the following markings that is plainly visible after installation:
 - a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
 - b. Supply voltage, phase, frequency, and full-load current.
 - c. Power source or circuit ID.
 - d. Short-circuit current rating of the panel based on one of the following:
 - 1) Short-circuit current rating of a listed and labeled assembly.
 - 2) Short-circuit current rating established utilizing an approved method.
- F. Provide a window kit where indicated on the Drawings or where a transmitter with display is mounted inside a control panel. The window shall meet the following requirements:
 - 1. Safety plate glass.
 - 2. Secured by rubber locking seal.
 - 3. Allow full viewing of devices issuing visual process data or diagnostics.
- G. Lighting:
 - 1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
 - a. Covered or guarded.
 - b. Provide On-Off door-activated switches where indicated on the Drawings.
 - c. 120-volt, single-phase, 15-amp style plug.
 - d. Provide 4,000 K, 900 Lumens - LED fixture.
 - 1) Provide additional fixtures for every 36 inches of width.
- H. Receptacles / Programming port:
 - 1. Provide 1 duplex receptacle located every 4 feet of enclosure width, spaced evenly along the back mounting panels.
 - 2. GFCI, 120-volt, single-phase, 15-amp style plug.
 - 3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.
 - 4. Programming port with GFCI shall be mounted on the front of the panel as indicated in the Contract drawings to facilitate easy connection to the PLC.
- I. Grounding:
 - 1. Provide the following:
 - a. Grounding strap between enclosure doors and the enclosure.
 - b. Equipment grounding conductor terminals.
 - c. Provide equipment grounding busbar with lugs for connection of all equipment grounding wires.
 - d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding busbar.

2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND," the letter "G," or the color green.
3. Signal cable shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
8. Unless otherwise noted, connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.

2.8 FINISHES

A. Finishes:

1. Metallic (non-stainless):
 - a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
 - b. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry-film thickness and allowed to dry before applying the finish coat.
 - c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
 - d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.
2. Stainless steel:
 - a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

B. Colors:

1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
3. Panel interiors shall be manufacturer's standard white.

2.9 SOURCE QUALITY CONTROL

- ### A.
- As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
 - 1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.2 INSTALLATION

- A. Install enclosures so that their surfaces are plumb and level within 1/8-inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.
- B. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.
- C. Provide floor stand kits for wall-mounted enclosures larger than 48 inches high.
- D. Provide concrete housekeeping pads for freestanding enclosures.
 - 1. Refer to the structural typical details.
- E. Install gasket and sealing material under panels with floor slab cutouts for conduit:
 - 1. Undercoat floor-mounted panels.
- F. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.
- G. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miscut holes shall require that the entire enclosure be replaced.
- H. Protect all wiring from sharp edges and corners.
- I. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule, but shall be shown on the Loop Drawings prepared by the Contractor.
- J. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.
- K. Side panels:
 - 1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

3.3 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.4 CLEANING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.5 PROTECTION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

+ + END OF SECTION + +

SECTION 40 68 00

CONTROL SYSTEMS: PCS SOFTWARE

PART 1 – GENERAL

1.1 SUMMARY

- A. ICSC shall use OWNER's existing AVEVA Wonderware systems platform SCADA software and licenses to deploy the SCADA HMI displays and modifications related to the pump station upgrade. ICSC shall coordinate with OWNER to obtain software versions, development / runtime licensing information and add-on modules required to provide a fully functional system. CONTRACTOR may choose to use their own software and licenses for configuration and testing of the SCADA HMI screens, alarms, and reports.
- B. ICSC shall use OWNER's existing Alarm notification software, WIN-911 and Reporting software, Sytech XL Reporter software and licenses for deployment of alarm notification and reports configurations related to the pump station upgrade.
- C. ICSC shall use their own software and license to develop and test the SCADA HMI displays, alarms, and reports prior to field deployment.
- D. Provide copies of all software on USB Flash Drive, or equivalent media. For completely developed systems, provide a copy of the virtual machine developed on USB Flash Drive.
- E. Security:
 - 1. Integrate software systems with the OWNER's existing Active Directory infrastructure for authentication. Coordinate with OWNER any required whitelisting of applications or ports for proper operation of software.
 - 2. User Groups:
 - a. The system will use User Groups to assign screen access and control action permissions within the system dependent on the login credentials of the user.
 - b. A user group with minimal permissions will always be logged in if no other user group is logged in. This user group will be limited to view only and basic screen navigation.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.4 SUBMITTALS

Home Depot MPS and FM
PCS Software
30036073

- A. Furnish submittals as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Remote alarm database:
 - 1. After development of the PCS system database but before system start-up, provide a list of points configured for alarming and submit to the OWNER and the ENGINEER. The OWNER/ENGINEER will identify critical alarms for use in the extended alarming system (e.g. dialer system, paging) and provide response descriptions.
- C. Alarm descriptions shall be of sufficient detail for an accurate review by the OWNER.
- D. After all shop drawings submittals required in this Section have been favorably reviewed by the ENGINEER, the ICSC shall submit the following items, which must also be favorably reviewed and implemented prior to the start of system testing, the entire control system including all required software packages must be operational prior to the required factory acceptance test:
 - 1. All operator interface display submittals shall be in full color as they will appear on the display screen:
 - a. This submittal shall be prepared after the requisite graphics meetings.
 - b. The submittal shall include:
 - 1) Graphic displays.
 - 2) Trend displays.
 - 3) Alpha numeric displays.
 - 4) Alarm displays.
 - 2. Each display shall be uniquely titled:
 - a. Locations for process data shall be clearly identified either through the use of simulated data or by showing variables on the displays and providing a reference list describing those variables.
 - b. All dynamic points shall be identified by tag number as a minimum and their operation shall be described on separate sheets:
 - 1) Color change.
 - 2) Symbol change.
 - c. Three sets of submittals, with screen prints in color on a white background, are required for review by the OWNER and ENGINEER.
 - d. One set will be returned with comments.
 - 3. All periodic and custom reports for the entire control system:
 - a. Locations for process data shall be clearly identified, either through the use of simulated data or by showing variables on the report and providing a reference list describing those variables.
 - b. Three sets of reports shall be submitted for review by the ENGINEER.
 - c. One set will be returned with comments.
- E. Pre-acceptance test documentation as specified in the Sequencing article of this Section.

- F. Operator's reference manual:
1. The ICSC shall prepare and submit a user reference manual for the operator interface system for use by the operators. This manual shall be bound in a 3-ring binder and meet the following minimum requirements:
 - a. An index to the manual.
 - b. A list of operator interface:
 - 1) Display screens.
 - 2) Trends.
 - 3) Reports.
 - 4) With display name and description.
 - c. A summary of all possible commands and operator inputs to these screens including setpoints:
 - 1) All control actions shall be included.
 - d. A control system block diagram with names and locations of major components.
 - e. Instructions for manually printing screens or reports.
 - 1) Real time.
 - 2) Historical.
 - f. A summary of security levels and their privileges and limitations.
 - g. Spaces for operators to make notes.
 2. A copy of this manual shall be provided to each operator during training on the operator interface operations:
 - a. The training class shall include a review of this manual with the operators in addition to more detailed instruction on the operator interface configuration and its use.
- G. Review meeting minutes submittals:
1. Submit meeting minutes for the Graphics, Report, Alarms, and Network Management described.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. The manufacturer must have a formal and documented set of quality assurance procedures that are applied to the engineering design, development, and documentation of the software:
1. The presence of a formal quality assurance department is required.

1.6 SEQUENCING

- A. The following items shall be submitted with the final sets of technical manuals required as specified in the Submittals article of this Section, 15 working days before the pre-commissioning test as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems:
1. All program manuals supplied by the manufacturers with the standard software packages.
 2. All original program disks supplied by the manufacturers with the

standard software packages, including any program revisions or updates issued by the manufacturers during the construction period.

3. All PLC program and operator interface application program files stored on labeled disks:
 - a. The PLC program and operator interface application program file disks shall also be updated as required if any changes or corrections are required in this programming before Project completion.

B. Operator interface graphics generation:

1. The ICSC through the Contractor shall schedule the operator interface graphics meetings.
2. Topics shall include graphics for:
 - a. HMI graphics.
 - b. Data acquisition and graphics display system.
3. The OWNER and ENGINEER shall attend these meetings.
4. Graphics Meeting No. 1: Held in conjunction with the Preliminary Meeting as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems:
 - a. The ICSC shall chair and develop an agenda 3 weeks in advance of the meeting, which shall address the basic criteria to be adhered to in the configuration and development of graphic displays:
 - 1) At this meeting, the ICSC shall distribute sample display formats for illustration purposes.
 - 2) As a minimum, this meeting shall address the following issues:
 - a) All in-plant and remote site areas and conventions for identifying tag names and descriptors.
 - b) Designation of groups within each plant area along with tag names and descriptors.
 - c) The assignment of individual control loops and inputs to specific groups.
 - d) Organization of the systems universal display hierarchy.
 - e) Paging schemes to be used to enable the movement from one display to another.
 - f) An itemization of the type of display to be used at each level in the graphic hierarchy, i.e., pre-formatted displays, templates, custom graphics, etc.
 - g) Color convention to be employed on all graphics for the annotation of various status information, differentiation between alarms based on alarm priority, background colors, static field colors, and dynamic field colors.
 - h) The utilization of blinking and conditional text.
 - i) Definition of graphic symbolism to be used on the Project. This listing shall include but not be limited to symbols to be used for process instrumentation, process equipment, piping, vessels and valves:
 - (1) All symbolism must be specific as opposed to generic in that shapes must define both function and type, i.e., specific symbols for each valve design, each pump design, each type of flowmeter, etc.
 - (2) If the ICSC's library of shapes does not adequately

describe plant or field conditions, the ICSC shall develop additional shapes to meet the plant or field requirements.

- (3) Shapes and symbols used on the P&IDs shall be used as a guideline.
 - j) Definition of all display select commands that enable the operator to move within the display hierarchy.
 - k) The utilization of cursor movement commands which enable the operator to move within a display.
 - l) Definition of control input commands which enable the operator to interact with face plates control stations and custom graphic displays to implement control functions.
 - m) Definition of data input commands which enable the operator to enter numeric values into the control system.
 - n) Definition of the utilization of "poke" points or fields that are dynamically sensitive to operator inputs to facilitate operator entry directly into graphic displays.
 - o) A review of graphic generation procedures.
- b. Subsequent to the adjournment of Graphics Meeting No. 1, the ICSC shall prepare and formalize a document titled "Graphics Criteria" which shall contain detailed meeting minutes and a definition of all graphic guidelines to be adhered to:
 - 1) This report shall be supplemented by graphic examples which illustrate the incorporation and application of each graphic criteria.
 - 2) The report shall be submitted within 30 calendar days of the meeting's adjournment.
5. Graphics Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems:
 - a. Subsequent to the finalization of the overall system-wide graphics criteria, the ICSC shall develop graphic packages for the entire operator interfaces being furnished under this Project.
 - b. At this meeting, the ICSC shall submit 5 copies including:
 - 1) A review of the graphic package developed for the process areas for content and completeness.
 - 2) A review of all data fields that display automatically updated process information.
 - 3) A review of all required input commands associated with the graphic access and control manipulation.
 - c. Subsequent to the adjournment of Graphics Meeting No. 2, the ICSC shall prepare a formalized submittal of the graphic package for review along with the detailed meeting minutes:
 - 1) The report shall be submitted within 30 calendar days of the meeting adjournment.
6. 10 additional displays shall be configured on-line during the pre-commissioning test period.

C. Report generation:

1. The ICSC through the Contractor shall schedule the report generation

meetings.

2. The OWNER and ENGINEER shall attend these meetings.
3. Reports Meeting No. 1: Held in conjunction with the preliminary meeting as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems:
 - a. The ICSC shall chair and develop an agenda 3 weeks in advance for a meeting, which shall address the basic criteria to be adhered to in the configuration and development of the reports:
 - 1) At this meeting, the ICSC shall distribute sample formats for illustration purposes.
 - 2) As a minimum, this meeting shall address the following issues:
 - a) All in-plant and remote site data and conventions for identifying tag names and descriptors.
 - b) Designation of groups within each plant area along with tag names and descriptors.
 - c) The assignment of inputs to specific categories.
 - d) Organization of the systems universal report categories.
 - e) An itemization of the type of report available.
 - f) Definition of terms to be used on the reports.
 - g) Definition of all report commands that enable the operator to move within the report editor.
 - h) The utilization of cursor movement commands which enable the operator to move within a report.
 - i) Definition of data input commands which enable the operator to enter numeric values into the system.
 - j) A review of report generation procedures.
 - 3) Subsequent to the adjournment of the Report Meeting No. 1, the ICSC shall prepare and formalize a document titled "Report Criteria" which shall contain detailed meeting minutes and a definition of all report guidelines to be adhered to:
 - a) This report shall be supplemented by report examples.
 - b) The report shall be submitted within 30 calendar days of the meeting's adjournment.
4. Reports Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems:
 - a. Subsequent to the finalization of the overall report format criteria, the ICSC shall develop report packages for review.
 - b. At this meeting, the ICSC shall submit 5 copies including:
 - 1) A review of the report package developed for the process area(s) for content and completeness.
 - 2) A review of all data fields for process information.
 - 3) A review of all required input commands associated with the report access and control manipulation.
 - c. Subsequent to the adjournment of Report Meeting No. 2, the ICSC shall prepare a formalized submittal of the report package for review along with the detailed meeting minutes:
 - 1) The report shall be submitted within 30 calendar days of the meetings adjournment.
5. 10 additional reports shall be configured on-line during the pre-

commissioning test period.

D. Alarming priority:

1. The ICSC through the Contractor shall schedule the alarming priority meetings.
2. The OWNER and ENGINEER shall attend these meetings.
3. Alarming Priority Meeting No. 1: Held in conjunction with the preliminary meeting as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems:
 - a. The ICSC shall chair and develop an agenda 3 weeks in advance for a meeting, which shall address the basic criteria to be adhered to in the prioritization of alarms:
 - 1) At this meeting, the ICSC shall distribute a listing of all plant alarms identified by tag names and descriptors.
 - 2) As a minimum, this meeting shall address the following issues:
 - a) Criteria for prioritizing alarms including alarming priority levels. (i.e., Priority 3 - alarm at PCS; Priority 2 - alarm at PCS and autodialer; Priority 1 - alarm at PCS, autodialer, and plant shutdown.)
 - b) Alarm display banner basic criteria.
 - 1) Subsequent to the adjournment of the Alarming Priority Meeting No. 1, the ICSC shall prepare and formalize a document titled "Alarm Criteria" which shall contain detailed meeting minutes and a definition of all alarming guidelines to be adhered to:
 - a) The report shall be submitted within 30 calendar days of the meeting's adjournment.
4. Alarming Priority Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems:
 - a. Subsequent to the finalization of the overall alarm criteria, the ICSC shall develop an alarming priority spreadsheet that will be populated at this meeting.
 - b. At this meeting, the ICSC shall provide a spreadsheet including:
 - 1) A listing of all plant alarms identified by tag names and descriptors.
 - 2) For each alarm listed include a location to enter the alarm priority assignment.
 - 3) For each alarm listed include a location to enter specific comments related to that alarm.
 - c. Subsequent to the adjournment of Alarming Priority Meeting No. 2, the ICSC shall prepare a formalized submittal of the alarming priority spreadsheet for review along with the detailed meeting minutes:
 - 1) The spreadsheet and meeting minutes shall be submitted within 30 calendar days of the meeting's adjournment.

E. Standard Software and Network Management:

1. The ICSC through the Contractor shall schedule the standard software and network management meetings.
2. The OWNER and ENGINEER shall attend these meetings.
3. Software Meeting No. 1: Held in conjunction with the preliminary meeting as specified in Section 40 60 00 - Common Work Results for Process

Control and Instrumentation Systems:

- a. The ICSC shall chair and develop an agenda 3 weeks in advance for a meeting, which shall address the basic criteria to be adhered to in the configuration of standard software and network management capabilities:
 - 1) At this meeting, the ICSC shall distribute a listing of all planned software and network connected equipment.
 - 2) As a minimum, this meeting shall address the following issues:
 - a) Software licensing and version requirements.
 - b) Software configuration including:
 - (1) Standard OS images
 - (2) Active Directory integration
 - (3) Updating and patching
 - c) Implementation or integration of OWNER provided software such as Anti-Virus.
 - d) Backup and Recovery.
 - e) Device naming conventions.
 - f) Device group policies.
 - g) Determination of devices to be managed by the OWNER's EIT department versus the SCADA system. Parameters to be monitored on each network connected device via SNMP or other protocol and coordination for provision of MIB files.
 - h) Subnets and VLANs to use for network management, patch management, and backup systems.
 - i) Network configuration changes required for communication to devices.
 - 3) Subsequent to the adjournment of the Software Meeting No. 1, the ICSC shall prepare and formalize a document titled "Software and Network Management Criteria" which shall contain detailed meeting minutes, a listing of software configuration guidelines, and a listing of all network management I/O to be monitored organized by device name, I/O point, units, and MIB file point identification:
 - a) The report shall be submitted within 30 calendar days of the meeting's adjournment.
4. Software Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems:
 - a. Subsequent to the finalization of the overall standard software implementation and network management configuration, the ICSC shall develop update the lists of software configurations and network management I/O that have been or are planned to be implemented.
 - b. At this meeting, the ICSC shall prepare and agenda to discuss the following:
 - 1) Current status of software implementation.
 - 2) Software configuration issues encountered.
 - 3) Discussion on how to address issues.
 - 4) Status of network management and monitoring implementation.
 - 5) Network management and monitoring changes made or

- planned to be made.
- 6) Associated impact of the changes.
- 7) Required coordination and scheduling with OWNER's EIT group to complete all implementations.
- 8) Resolutions to all issues.
- c. Subsequent to the adjournment of Software Meeting No. 2, the ICSC shall prepare a formalized submittal of the network monitoring I/O spreadsheet for review along with the detailed meeting minutes:
 - 1) The spreadsheet and meeting minutes shall be submitted within 30 calendar days of the meeting's adjournment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.2 FIELD QUALITY CONTROL

- A. Test all software provided as part of this Section as part of the system tests specified in Section 40 80 00 - Commissioning for Instrumentation and Controls.
- B. Provide training by a factory-authorized vendor, where applicable.
- C. Contractor shall cover the costs of tuition, training materials, and related fees, as well as travel and subsistence expenses for the attendees.

3.3 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems and 40 80 00 - Commissioning for Instrumentation and Controls.

+ END OF SECTION + +

SECTION 40 71 13

FLOW MEASUREMENT: MAGNETIC FLOWMETERS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Full-body magnetic flowmeters.
- B. Provide all instruments identified in the Contract Drawings.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. International Organization for Standardization (ISO):
 - 1. 9000 - Quality management systems -- Fundamentals and vocabulary.
 - 2. 17025 - General requirements for the competence of testing and calibration laboratories.
- C. National Institute of Standards and Technology (NIST).
- D. NSF International (NSF).

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.4 SUBMITTALS

- A. Furnish submittals as specified in Sections 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Include sizing information from the manufacturer that includes:
 - 1. Chart of the measurement error from zero to maximum measured volumetric flow range indicated in data sheets.
 - 2. Indication of all input parameters and their values used in the calculations.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:

1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.8 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.9 MAINTENANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Provide the following:
1. Siemens: SITRANS F M MAG 5100.

2.2 MANUFACTURED UNITS

- A. Magnetic flowmeter:
1. General:
 - a. Magnetic flowmeters obtain the flow velocity by measuring the changes of induced voltage of the conductive fluid passing across a controlled magnetic field.
 - b. Complete zero stability shall be an inherent characteristic of the flowmeter system.
 - c. Include for each magnetic flow metering system:
 - 1) A metering tube with electrodes (sensor).

- 2) Signal cable.
- 3) Transmitter integral or remote as indicated on the Drawings.
- 4) Flowmeter grounding rings.
2. Performance requirements:
 - a. Accuracy:
 - 1) 0.25 percent of flow rate from 10 to 100 percent of full-scale for velocities ranging between 1.9 to 10 feet per second.
 - b. Repeatability:
 - 1) 0.25 percent of rate.
3. Element:
 - a. Metering tube:
 - 1) Constructed of carbon steel with corrosion resistant coating or Type 304 stainless steel (unless specifically noted otherwise in the instrument data sheets) with flanged connections to match with piping material.
 - 2) Liner material shall be hard rubber, in conformance with:
 - a) Manufacturer's recommendations for the intended service.
 - b) NSF certified for all drinking water applications.
 - 3) Electrodes type and material shall be Hastelloy C-276, in conformance with:
 - a) Manufacturer's recommendations for the intended service.
 - 4) Meter terminal housing NEMA Type 4X, unless installed in locations such as vaults that will experience submergence. In those applications NEMA 6P is required.
 - b. Unless specifically noted otherwise in the instrument data sheets.
 - 1) Meter coating consisting of epoxy painted finish.
 - 2) Components:
 - a) 2 grounding rings:
 - (1) Which are in conformance with the manufacturer's bore and material recommendation for the meter's intended service.
 - (2) Designed to protect and shield from abrasion of the liner's edge interface at the meter's end.
 - 3) Provide meter with appropriate approvals for hazardous locations where required.
4. Transmitter:
 - a. Power supply:
 - 1) 120VAC, 60 Hz.
 - 2) Power consumption: 60 VA maximum.
 - b. Outputs:
 - 1) As noted in the Contract Drawings.
 - 2) For all instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.
 - c. NEMA 250 Type 4X enclosure, remote mounted from flow tube.
 - d. Microprocessor-based signal converter/transmitter.
 - e. Utilize DC pulse technique to drive flux-producing coils.

- f. Contain a 6-digit display for flow rate, percent of span, and totalizer.
- g. Operator keypad interface.
- h. Integral zero return to provide consistent zero output signals in response to an external dry contact closure.
- i. Integral low flow cut-off zero return.
- j. Programmable parameters including:
 - 1) Meter size.
 - 2) Full-scale flow rate.
 - 3) Magnetic field frequency.
 - 4) Time constant.
- k. Data retention for a minimum of 5 years without auxiliary main or battery power.
- l. Self-diagnostics and automatic data checking.
- m. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
- n. Ambient operating temperature limits of -5 to 140 degrees Fahrenheit (-20 to 60 degrees Celsius).

2.3 ACCESSORIES

- A. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.
- B. Provide sunshades for all transmitters located outdoors.
- C. Provide galvanic isolation gaskets, nylon/Teflon™ flange bolt insulation bushings and nylon washers on all meters installed on pipes with cathodic protection.
- D. Furnish 1 spool piece for every size of magnetic flow tube being provided.
- E. Electronic tester for calibration verification and diagnostics.
 - 1. Transmitter shall have continuous internal meter verification method comparing current meter system values to base line value.
 - 2. Should variance in readings be determined exceeding a preset limit the transmitter will provide an alarm condition via a configurable discrete output.

2.4 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Factory calibrate each flow metering system at a facility that is traceable to the NIST. ISO-17025 accredited test facility with certified accuracy traceable to NIST.
- C. Evidence of accreditation shall originate from a national verification agency such as A2LA.

- D. A real-time computer-generated printout of the actual calibration date indication actual velocities and as read values of the flow tube.
 - 1. Flow calibration report of the manufacturers flow lab calibration procedure shall be shipped with the meter system.
 - 2. Minimum calibration shall be a 3-point calibration including 1, 3, and 10 feet per second velocities for every meter and transmitter system.
 - 3. Manufacturer shall archive all calibration reports for future reference.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. For instruments located outdoors or where instrument elements and transmitters are separated by conduit located outside the building envelope, provide surge protection devices at the transmitters.

3.2 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide manufacturer's services to perform installation inspection.

3.3 ADJUSTING

- A. Field Verification:
 - 1. Verify factory calibration of all instruments in accordance with the manufacturer's instructions.
 - 2. The transmitter and sensor to include a method to verify flow meter performance to the original manufacturer specifications.
 - 3. Verification should be traceable to factory calibration using a third party, attested onboard system pursuant to ISO standards.
 - 4. The verification report should be compliant to common quality systems such as ISO 9000 to prove reliability of the meter specified accuracy.
 - 5. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.4 CLEANING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.5 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

- B. Demonstrate performance of all instruments to the Engineer before commissioning.

3.6 PROTECTION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.7 SCHEDULES

- A. Provide all instruments identified in the Contract Documents:
 - 1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

+ + END OF SECTION + +

SECTION 40 72 00

LEVEL MEASUREMENT: RADAR PULSE TIME OF FLIGHT (PTOF)

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Non-contact radar (PTOF) level instruments.
 - 2. Level Switch, Suspended Float Type
- B. Provide all instruments identified in the Contract Documents.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 - 1. PTOF: Pulse Time of Flight.
 - 2. FDT: Field Device Tool.
 - 3. DTM: Device Type Manager.

1.4 SUBMITTALS

- A. Furnish submittals as specified in Sections 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. For each instrument with digital bus communication protocol:
 - 1. Provide FDT certificate for the instrument's DTM.
 - 2. FDT certificate to be approved and listed by the FDT Group.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.
- C. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:

- a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- D. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.6 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.8 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. In addition to the requirements of Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems provide extended manufacturer's warranty for each instrument for a period of 2 years after project substantial completion.

1.9 MAINTENANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Provide the following or equal:
1. Siemens, LR250.

2.2 MANUFACTURED UNITS

- A. Pulse Time of Flight:
1. General:
 - a. Instrument emits radar pulses via a transmitter, with a frequency range of 6.3 GHz to 26 GHz.
 - b. The pulses reflect from the surface being measured and are received back at the instrument via a sensor.
 - c. The instrument measures the pulse travel time between the transmitter,

- surface, and receiver to calculate the level.
- d. Safety:
 - 1) Shall not generate frequency waves with power levels hazardous to humans.
- 2. Performance requirements:
 - a. AccuracyLevel:
 - 1) 0.25-inch.
- 3. Element:
 - a. Level element must conform to the process material compatibility as indicated on the Instrument Data Sheets or the Instrument Index.
 - b. Connections:
 - 1) Process: The antenna design shall be suitable for mounting in a nozzle as indicated on the Instrument Data Sheets or the Instrument Index.
 - 2) The design shall be such that product condensation on the antenna shall not affect the performance of the gauge. It shall be possible to choose between either parabolic-, cone-, rod-shaped antennas.
- 4. Transmitter:
 - a. Microprocessor-based signal converter/transmitter.
 - b. Power supply:
 - 1) 24 VDC - 2-wire loop powered.
 - 2) Power consumption: 15 VA maximum.
 - c. Outputs:
 - 1) Isolated 4-20 mA DC with HART communication protocol.
 - d. Backlit digital display for level or volume.
 - e. Self-diagnostics and automatic data checking.
 - f. Signal integrity:
 - 1) Immune to radio frequency and electromagnetic interference with field strength of 15 volts/meter or less over a frequency range of 50 Hz to 460 MHz.
 - 2) Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition on indicating transmitter unit.
 - g. Protected terminals and fuses in a separate compartment, which isolates field connection from electronics.
 - 1) Indication: Local - 5-digit display.
 - h. Enclosure rating: NEMA Type 4X.
 - i. Instruments located within hazardous classified areas shall be explosion proof with appropriate approvals for:
 - 1) Class I, Division 1 and 2, Group A, B, C, and D.
 - j. Electrical connection: 1/2-inch male NPT.

2.3 LEVEL SWITCH, SUSPENDED FLOAT TYPE:

- A. Float switches shall be of non-mercury displacement type, encapsulated in polyurethane or vinyl floats. Float switches shall be certified for use in potable water systems.
- B. Units shall be waterproof shockproof explosion-proof and equipped with sufficient submersible cable to extend to the control panel or

- junction box without splicing.
- C. Any required weights shall be provided. switches shall be suspended on a suitable rack or rail of stainless-steel construction.
- D. Suspended type float switches shall be Flygt, ENM-10, Anchor Scientific Eco Float or equal.

2.4 ACCESSORIES

- A. Software: Provide Windows based PC Software for configuration and echo mapping.
- B. Provide sun shield for outdoor installations.
- C. Factory calibrate each level transmitter at a facility that is traceable to NIST.
- D. Provide complete documentation covering the traceability of all calibration instruments.

2.5 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Factory calibrate each level transmitter at a facility that is traceable to NIST.
- C. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 – EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.4 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.5 ADJUSTING

- A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions:
 - 1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.6 CLEANING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.7 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Demonstrate performance of all instruments to the Engineer before commissioning.
- C. Furnish 2 hours of Owner training.

3.8 PROTECTION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.9 SCHEDULES

- A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
 - 1. Instruments may be indicated on the Drawings, specified in the Specifications or both.

+ + END OF SECTION + +

SECTION 40 72 43

PRESSURE MEASUREMENT: SUBMERSIBLE

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Submersible pressure transmitters.
- B. Provide all instruments identified in the Contract Documents.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.4 SUBMITTALS

- A. Furnish submittals as specified in Sections 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide complete documentation covering the traceability of all calibration instruments.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify the compatibility with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.
- D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.6 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.7 PROJECT OR SITE CONDITIONS

- A. Project environmental conditions as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
 - 1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.8 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.9 MAINTENANCE

- A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Submersible level measurement with 2-wire integral transmitter:
 - 1. One of the following or equal:
 - a. PT-500 manufactured by Automation Products Group, Inc

2.2 MANUFACTURED UNITS

- A. Submersible level measurement with 2-wire integral transmitter:
 - 1. General:
 - a. Pressure is measured through a diaphragm-type measuring cell and converted to linear pressure measurement.
 - b. Each submersible pressure transmitter system shall include:
 - 1) Signal cable, including pressure compensation tube.
 - 2) Transducer probe with integral transmitter.
 - 3) Transmitter cable termination box.
 - 2. Performance requirements:
 - a. Accuracy:
 - 1) 0.3 percent of range.
 - b. Repeatability:
 - 1) 0.25 percent of full scale.
 - c. Rangeability:

- 1) 3:1.
- d. Range:
 - 1) As indicated on the contract documents.
- 3. Element:
 - a. Sensor housing shall be Type 316L stainless steel or titanium with ceramic, teflon-coated, or titanium diaphragm.
 - b. Protective cap shall be manufacturer's recommended material, chemically resistant to process fluid.
 - c. Slip resistant extension cable with pressure compensation tube with Teflon filter.
 - d. Enclosure for probe and transmitter assembly shall be NEMA Type 6P.
 - e. When used in Hazardous locations must include approvals for Class I Div. I.
 - f. When used in potable water applications must include NSF 61 certifications.
- 4. Transmitter:
 - a. Power supply:
 - 1) 24 VDC: 2 wire loop powered.
 - 2) Power consumption: 18 VA maximum.
 - b. Outputs:
 - 1) Isolated 4 to 20 milliamperes DC.
 - c. Without display.
 - d. Ambient operating temperature limits of -10 to 70 degrees Celsius (-14 to 158 degrees Fahrenheit).
 - e. Transmitter shall be integral to probe housing.
- 5. Transmitter cable termination box:
 - a. NEMA Type 4X.
 - b. Equipped with filter or desiccant chamber to eliminate moisture from the pressure compensation tube.
 - c. Termination for signal wires and pressure compensation tube.

2.3 ACCESSORIES

- A. Type 316L stainless steel mounting clamp with Type 304 stainless steel mounting screws.
- B. Provide guide tube for stilling well mounting.
- C. Provide additional Type 316L stainless steel weight to prevent movement.
- D. Provide additional anchor to prevent movement.
- E. Provide cable clamp and strain relief.

2.4 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Factory calibrate each instrument with a minimum 3-point calibration

or according to Manufacturer's standard at a facility that is traceable to the NIST.

1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
 1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.4 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.5 ADJUSTING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.6 CLEANING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.7 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.8 PROTECTION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.9 SCHEDULES

- A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

+ + END OF SECTION + +

SECTION 40 73 26

PRESSURE/VACUUM MEASUREMENT: DIRECT

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Pressure transmitters and indicators.
 - 2. Pressure Gauges
- B. Provide all instruments identified in the Contract Documents.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 - 1. Lower range value (LRV): Lowest pressure that the pressure transmitter is capable of measuring.
 - 2. Upper range value (URV): Highest pressure that the pressure transmitter is capable of measuring.
 - 3. Calibrated range: The range that the pressure transmitter is configured to measure. The low end of the calibrated range must be greater than the LRV of the transmitter. The high end of the calibrated range must be less than or equal to the URV. The calibrated range corresponds to the flow signal sent from the transmitter.

1.4 SUBMITTALS

- A. Furnish submittals as specified in Sections 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide complete documentation covering the traceability of all calibration instruments.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify the compatibility with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.

- 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.
- D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.6 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Project environmental conditions as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
 - 1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.8 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.9 MAINTENANCE

- A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Provide the following or equal:
 - 1. Emerson, Rosemount 3051 Series.

2.2 MANUFACTURED UNITS

- A. Pressure transmitters - direct:
 - 1. General:

- a. Pressure transmitter assembly shall include a diaphragm type pressure transducer and microprocessor based transmitter for measurement of gauge, vacuum, or absolute pressure.
- 2. Performance requirements:
 - a. Maximum ratio of total instrument range to calibrated span: 10 to 1.
 - b. Accuracy:
 - 1) Reference accuracy: Plus or minus 0.075 percent of calibrated span, including effects of hysteresis, nonlinearity, and repeatability.
 - 2) Total performance accuracy: Plus or minus 0.30 percent of calibrated span, including reference accuracy effects, static pressure and ambient temperature effects.
 - 3) Stability: Plus or minus 0.15 percent of upper range limit over 5 years.
- 3. Element:
 - a. Diaphragm type transducer integral to pressure transmitter.
 - b. Diaphragm material: Stainless steel or ceramic.
 - c. Process material compatibility:
 - 1) Verify all material compatibilities with the instrument manufacturer.
- 4. Transmitter:
 - a. Power supply:
 - 1) 24 VDC - 2 wire loop powered.
 - 2) Power consumption: 3 VA maximum.
 - b. Outputs:
 - 1) Isolated 4-20mA DC with HART communication protocol.
 - c. Provided with electronic microprocessor.
 - d. Adjustments: Adjustable electronic zero and span, with elevated or suppressed zero as required by application. Adjustment shall be possible without mechanical fulcrum points or handheld configurator.
 - e. Local display:
 - 1) 5-digit LCD.
 - 2) Scaled in engineering units.
 - f. Enclosure:
 - 1) NEMA Type 4X.
 - 2) NEMA Type 7 for hazardous locations as required.
 - g. Over range protection: To maximum process line pressure.
 - h. Conduit: 1/2-inch male NPT.
- 5. Components:
 - a. Transmitter mounting:
 - 1) Provide all necessary hardware for transmitter mounting.

2.3 PROCESS TAPS, AND SENSING LINES

- A. Pressure Tap Sensing Lines and Accessories for Pressure measuring Instruments:
 - 1. For Process Sensing Taps in Ductile Iron, Steel and Stainless-Steel Piping Systems:
 - a. Material and Fittings: Type 316 stainless steel pipe, ASTM A312; and threaded fittings and adapters, ASTM A403 or ASTM A778.
 - b. Sizes: diameter minimum for main sensing pipes and 1/4-inch diameter gauge and switch connections.

- c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the contract documents.
 - d. End Connections: Removable "Swagelok", or equal.
 - e. Accessories:
 - 1) For applications not requiring diaphragm seals provides separate 1/2-inch diameter Type 316 stainless steel threaded ball valve for each gauge and switch.
 - 2) For applications requiring diaphragm seals provides separate 1/2-inch diameter threaded Type 316 stainless steel ball valve for seal process side shutoff.
2. For Process Sensing Taps in Thermoplastic Piping Systems:
- a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. Provide PVC and CPVC piping in accordance with contract requirements for thermoplastic pipe.
 - b. Sizes: 1/2-inch diameter minimum for sensing pipes and instrument connections.
 - c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the contract documents.
 - d. Accessories:
 - 1) For copper piping system taps with or without seals, provide separate half inch diameter minimum threaded brass or bronze ball valve for each gauge and switch.
 - 2) For PVC and CPVC piping system taps with or without seals, provide separate half inch diameter threaded ball valve for process sensing line shutoff.

2.4 PRESSURE GAUGE

- A. Type: Bourdon Tube Pressure Element Type, Liquid Filled Gauge (for pressure ranges of 15 psi and greater and vacuum ranges to 30-inches Hg):
- B. Performance Requirements:
 - 1. Range: 0-60 PSI
 - 2. Accuracy: ± 0.5 percent of span (ANSI B40.1 Grade 2A).
- C. Construction Features:
 - 1. Case:
 - a. Solid front design constructed of glass filled polyester.
 - b. Color: Black.
 - 2. Size: 4-1/2-inch.
 - 3. Ring: Threaded, glass filled polyester.
 - 4. Window: Glass.
 - 5. Dial: White with black markings.
 - 6. Filling Liquid: Silicone
 - 7. Overpressure protection: Full blowout back.
 - 8. Bourdon Tube and Socket:
 - a. Type 316 stainless-steel.
 - b. Heliarc welded, unless otherwise specified.
 - 9. Movement:
 - a. Type 300 series stainless-steel.
 - b. Rotary geared with Teflon S coating, or cam and roller type.

- c. Built-in overload and underload movement stops.
- 10. Connection: 1/4-inch male NPT, bottom.
- 11. Mounting: Stem Mount.
- 12. Calibration:
 - a. Adjustable pointer.
 - b. Externally accessible zero adjustment.
- D. Accessories:
 - 1. Pressure Snubber: Sintered stainless-steel snubber threaded into gauge socket or in external stainless-steel housing with 1/4-inch NPT male and female connections.
 - 2. Process Isolation: Provide ball valves for process isolation in accordance with the requirements of Article 2.3, above.
- E. Products and Manufacturers: Provide one of the following:
 - 1. Ashcroft, Duragage 1279 Series.
 - 2. Helicoid, Series 900.
 - 3. Wika EN 837.
 - 4. Or equal.

2.5 ACCESSORIES

- A. Provide valve manifolds as specified in Section 40 79 00 - Pressure/Vacuum Measurement: Instrument Valves:
 - 1. Mount valve manifold integrally to the transmitter.
 - 2. Valve manifold and transmitter shall be assembled by Manufacturer and shipped as an assembly.
- B. Provide remote or integral diaphragm seals as specified in the Instrument Data Sheets and in Section 40 73 63 - Pressure/Vacuum Measurement: Diaphragm and Annular Seals.
- C. Provide sunshades for outdoor installations.
- D. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.6 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
 - 1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
 - 1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.4 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.5 ADJUSTING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.6 CLEANING

- B. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.7 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.8 PROTECTION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.9 SCHEDULES

- A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
 - 1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

+ + END OF SECTION + +

SECTION 40 73 63

PRESSURE/VACUUM MEASUREMENT

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Diaphragm seals.
 - 2. Annular seals.
- B. Provide all seals identified in the Contract Documents.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.4 SUBMITTALS

- A. Furnish submittals as specified in Sections 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Additional requirements:
 - 1. Product data:
 - a. Manufacturer's installation instructions.
 - b. Seal type.
 - c. Body materials.
 - d. Diaphragm material.
 - e. Fill fluid type.
 - f. Seal size.
 - g. Options.
 - h. Process connection.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify the compatibility with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.

- c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.6 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.8 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.9 MAINTENANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide spare annular seal for every size indicated in the project.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Diaphragm seals:
 - 1. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch gauge: Provide the following:
 - a. Ashcroft:
 - 1) Flushing connection: Type 741.
 - 2) Without flushing connection: Type 740.
 - 2. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures greater than or equal to 15 pounds per square inch gauge: Provide the following:
 - a. Ashcroft:
 - 1) Flushing connection: Type 201.
 - 2) Without flushing connection: Type 200.
- B. Annular seals:
 - 1. Provide the following:
 - a. Ashcroft, Wafer Isolation Ring.

2.2 MANUFACTURED UNITS

A. Diaphragm seals:

1. General:
 - a. Diaphragm seal and pressure instrument shall be assembled by pressure instrument manufacturer and shipped as an assembly.
2. Requirements:
 - a. Seal type:
 - 1) Metallic diaphragm: Welded to upper housing.
 - 2) Elastomer diaphragm: Bonded to upper housing.
 - b. Process connection: 1 inch NPT.
 - c. Instrument connection: 1/2 inch NPT.
 - d. Material Construction: Type 316 Stainless Steel.
 - e. Provide 1/4-inch flushing connection in diaphragm lower housing or provide flushing ring.
 - f. Flush port plug: Same material of construction as diaphragm lower housing.
 - g. Provide fill/bleed connection.
 - h. Mounting: As indicated in the Contract Documents.
 - i. Provide Type 316 stainless steel armored capillary for all remote installations.
 - j. Nuts and bolts: Type 316 stainless steel.
 - k. Materials of construction:
 - 1) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch:
 - a) Diaphragm: Type 316 stainless steel.
 - b) Lower housing: Type 316 stainless steel.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicon oil.
 - 2) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures greater than 15 pounds per square inch:
 - a) Diaphragm: Type 316 stainless steel.
 - b) Lower housing: Type 316 stainless steel.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicon oil.
 - 3) Chlorine:
 - a) Diaphragm: Tantalum.
 - b) Lower housing: Hastelloy C.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Halocarbon.
 - 4) Ferric chloride:
 - a) Diaphragm: PTFE or tantalum.
 - b) Lower housing: PVC or titanium.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicon oil.
 - 5) Fluorosilicic acid:
 - a) Diaphragm: Viton.
 - b) Lower housing: PVC.

- c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicon oil.
- 6) Hydrochloric acid:
 - a) Diaphragm: PVDF or tantalum.
 - b) Lower housing: Hastelloy B2.
 - c) Upper housing: Manufacturer's Standard.
 - d) Fill fluid: Fluorolube.
- 7) Ozone:
 - a) Diaphragm: Type 316 stainless steel.
 - b) Lower housing: Type 316 stainless steel.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Halocarbon.
- 8) Potassium permanganate:
 - a) Diaphragm: PTFE or tantalum.
 - b) Lower housing: PVDF or titanium.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Halocarbon.
- 9) Sodium permanganate:
 - a) Diaphragm: PTFE.
 - b) Lower housing: PVDF.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Halocarbon.
- 10) Sodium bisulfite:
 - a) Diaphragm: Tantalum.
 - b) Lower housing: Titanium.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicon oil.
- 11) Sodium hydroxide:
 - a) Diaphragm: Monel.
 - b) Lower housing: Monel.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicon oil.
- 12) Sodium hypochlorite:
 - a) Diaphragm: Tantalum.
 - b) Lower Housing: Titanium.
 - c) Upper Housing: Manufacturer's standard.
 - d) Fill Fluid: Halocarbon.
- 13) Sulfur dioxide:
 - a) Diaphragm: PTFE or tantalum.
 - b) Lower housing: PVDF or titanium.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Halocarbon.
- 14) Sulfuric acid:
 - a) Diaphragm: PTFE or tantalum.
 - b) Lower housing: Hastelloy B2.
 - c) Upper housing: Manufacturer's Standard.
 - d) Fill fluid: Halocarbon.
- 15) Engineer's approval.

- B. Annular seals:
1. General:
 - a. Inside diameter of annular seal shall provide uninterrupted flow:
 - 1) There shall be no dead ends or crevices.
 - 2) Process flow shall be sufficient to make the annular seal self-cleaning.
 - b. The pressure sensing flexible cylinder shall measure pressure around the full inside circumference of the pipeline.
 2. Requirements:
 - a. Pressure rating: Equivalent to the ANSI flanges.
 - b. Materials of construction:
 - 1) Inner flexible cylinder: Manufacturer's standard.
 - 2) Body:
 - a) Type 316 Stainless Steel.
 - 3) Assembly flanges: To match adjacent piping.
 - 4) Fill fluid: Silicon oil.
 - c. Nominal pipe size: As indicated on the Drawings.
 - d. Process connection: Wafer.
 - e. Instrument connection: 1/2 inch NPT.
 - f. Provide isolating needle valve between annular seal and pressure instrument.

2.3 ACCESSORIES (NOT USED)

2.4 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 – EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.
- C. Do not use Teflon thread seal tape on pressure instruments with silicon oil fill fluid.

3.4 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.5 ADJUSTING (NOT USED)

3.6 CLEANING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.7 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.8 PROTECTION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.9 SCHEDULES (NOT USED)

+ + END OF SECTION + +

SECTION 40 79 00
INSTRUMENT VALVES

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Valve manifolds and instrument valves.
- B. Provide all valves identified in the Contract Documents.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.3 DEFINITIONS

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.4 SUBMITTALS

- A. Furnish submittals as specified in Sections 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Additional requirements:
 - 1. Product data:
 - a. Valve type.
 - b. Body material.
 - c. Size.
 - d. Options.
 - 2. Shop drawings:
 - a. Mounting details for all manifold valves.

1.5 QUALITY ASSURANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify the compatibility with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.
- D. Provide valves manufactured at facilities certified to the quality standards of ISO 9001.

1.6 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Protect valve manifolds and protective coatings from damage during handling and installation. Repair coating where damaged.

1.7 PROJECT OR SITE CONDITIONS

- A. Project environmental conditions as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
 - 1. Provide valves suitable for the installed site conditions including, but not limited to, material compatibility, process, and ambient temperatures.

1.8 WARRANTY

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

1.9 MAINTENANCE

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Valve manifold:
 - 1. One of the following or equal:
 - a. Anderson Greenwood.
 - b. Hex Valve.
 - c. Noshok.
 - d. Emerson, Rosemount.
- B. Block and bleed valve:
 - 1. One of the following or equal:
 - a. Anderson Greenwood.
 - b. Hex Valve.
- C. Gauge valve:
 - 1. One of the following or equal:
 - a. Anderson Greenwood.

- b. Hex Valve.
- D. Level sensor isolation valve:
 - 1. One of the following or equal:
 - a. Indu-Tech, Level Sensor Isolation Valve.
 - b. DeZURIK, Level Sensor Isolation Valve.
 - c. Tyco, Rovalve Isolation Knife Gate Valve.

2.2 MANUFACTURED UNITS

- A. Valve Manifolds:
 - 1. General:
 - a. Provide 2-valve, 3-valve, blowdown type 5-valve, or metering type 5-valve manifolds as indicated on the Drawings.
 - b. Valve manifolds shall have one piece bonnet with a metal to metal seal to the valve body below the bonnet threads.
 - 2. Requirements:
 - a. Bonnet lock pin to prevent accidental loosening.
 - b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
 - c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
 - d. Manifold valves shall have straight through portion for bi-directional flow and easy roddable cleaning.
 - e. Manifold valves shall allow for direct or remote instrument mounting.
 - f. Shall be able to withstand pressures up to 6,000 psi for soft seat valves and 10,000 psi for hard seat valves at maximum 200 degrees Fahrenheit.
 - g. Materials of construction:
 - 1) Body material: Type 316 stainless steel.
 - 2) O-Ring: Teflon.
 - h. 2-Valve manifolds:
 - 1) 1 isolation valve and 1 drain/vent and calibration valve.
 - i. 3-Valve manifolds:
 - 1) 2 isolation valves and 1 equalizing valve for differential pressure applications.
 - 2) Plugged vent connections used for vent/drain or calibration.
 - j. Blowdown 5-valve manifold:
 - 1) 2 isolation valves, 1 equalizing valve, 2 blowdown valves for differential pressure applications.
 - k. Metering 5-valve manifold:
 - 1) 2 isolation valves, 2 equalizing valves, 1 vent/drain and calibration valve for differential pressure applications.
- B. Block and bleed valves:
 - 1. General:
 - a. Valve shall provide process isolation and venting/draining capabilities.
 - b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
 - c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
 - d. Valve shall not be used with fluids with high solids content, such as raw wastewater or sludge.

- 2. Requirements:
 - a. Materials of construction:
 - 1) Body material: Type 316 stainless steel.
 - 2) O-Ring: Teflon.
- C. Gauge valves:
 - 1. General:
 - a. Valve shall provide process isolation and venting/draining capabilities.
 - b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
 - c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
 - 2. Requirements:
 - a. Materials of construction:
 - 1) Body material: Type 316 stainless steel.
 - 2) O-Ring: Teflon
- D. Level sensor isolation valves:
 - 1. General:
 - a. Valve shall provide process isolation from level diaphragm.
 - b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
 - c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
 - 2. Requirements:
 - a. Materials of construction:
 - 1) Body material: Type 316 stainless steel.
 - 2) Flange diameter size: 3 inches.

2.3 ACCESSORIES

- A. Provide tube fitting, female NPT, or pipe butt weld connections if necessary.
- B. Provide stainless steel concentric or eccentric pipe nipples when necessary.

2.4 SOURCE QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine the installation location and verify it will work properly when installed.
 - 1. Notify the Engineer promptly if any installation condition does not meet the manufacturer's recommendations or specifications.

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.4 FIELD QUALITY CONTROL

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.5 ADJUSTING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.6 CLEANING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.7 DEMONSTRATION AND TRAINING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Demonstrate performance of all valves to the Engineer before commissioning.

3.8 PROTECTION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.9 SCHEDULES (NOT USED)

+ + END OF SECTION + +

SECTION 40 80 00

COMMISSIONING FOR INSTRUMENTATION AND CONTROLS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Testing requirements that apply to process control and instrumentation systems for the entire Project.

1.2 REFERENCES

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Electronics Industries Alliance (EIA).
- C. Telecommunications Industry Association (TIA).

1.3 DEFINITIONS

- A. As specified in the Contract Documents and 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 - 1. Complete End-to-End Testing (CEET) - Signals are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
 - 2. Loop Validation Tests - Signals are tested from the field device to the PLC.
 - 3. Platform Testing: Testing of the PLC and SCADA/HMI at the manufacturer's shop to demonstrate the program's functionality based upon specified and designed control requirements.

1.4 SUBMITTALS

- A. Furnish submittals as specified the Contract Documents and 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. General:
 - 1. Reference additional detailed test submittal scheduling and prerequisite requirements as specified in the Sequencing article of Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- C. Overall test plan:
 - 1. Develop the PCIS system test submittals in consultation and cooperation with all applicable subcontractors.
 - 2. Develop and submit an overall testing plan for the PCIS. The overall test

plan to be reviewed and approved by the ENGINEER before detailed test plans, procedures, and forms will be reviewed.

3. Describe the test phases as they apply specifically to this Project and each process system.
4. Provide a preliminary testing schedule to show the sequence of tests and commissioning as they apply to each process system and each PLC.
5. Provide a description of factory tests. Describe what equipment will be included, what testing equipment will be used, and the simulator that will be used.
6. Provide examples of proposed forms and checklists.

D. Test procedures:

1. Develop and submit detailed test procedures to show that the integrated SCADA system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
2. Provide a statement of test objectives for each test.
3. Prepare specific procedures for each process system.
4. Describe sequentially the steps to be followed in verifying the correct operation of each process system, including all features described in the loop descriptions, control strategies, and shown in the P&IDs. Implied or generic test procedures are not acceptable.
5. Specify who will perform the tests, specifically what testing equipment will be used (including serial numbers and NIST-traceable calibration), and how the testing equipment will be used.
6. Describe the expected role of the ENGINEER, as well as any requirements for assistance from OWNER's staff.
7. Provide the forms and checklists to be used.

E. Test forms:

1. Submit completed calibration forms, test forms, and checklists.
 - a. Test forms shall include the detailed test procedures or shall include clear references to separate pages containing the complete test procedure applicable to each form. If references to procedures are used, the complete procedure shall be included with each test binder.
 - b. Every page of each test form shall include project name, date, time, name of person conducting the test, signature of person conducting the test, and for witnessed tests, place for signature of person (ENGINEER and OWNER) witnessing the test.
 - c. Sample test forms at the end of this Section show the minimum required content.
 - 1) The sample test forms have not been customized for this Project.
 - 2) Contractor shall develop and submit test forms customized for the Project and the specified test and submittal requirements.

F. FAT procedure additional minimal requirements:

1. Prepare and submit a FAT procedure which includes:
 - a. Control system testing block diagram.

- b. Estimated test duration.
- G. Details on the simulator construction, components, and operation. Testing binders:
 - 1. Sub-system to be tested, provide and submit a test binder containing all test procedures and individual test forms for the test. References to other documents for test procedures and requirements are not acceptable.
 - 2. Fill out in advance headings and all other information known before the test.
 - 3. Include applicable test plan information, as well as a list of all test prerequisites, test personnel, and equipment.
 - 4. Include or list reference material and provide separately at the time of the test.
 - 5. Record test results and verify that all test requirements and conditions have been met.
- H. Test reports:
 - 1. At the conclusion of each test, submit a complete test report, including all test results and certifications.
 - 2. Include all completed test binders, forms, and checklists.
 - 3. Submission, review, and acceptance of each test report is required before the start of the sub-system.
- I. Performance Acceptance Test Completion
 - 1. Submit the following documentation upon successful completion of the performance acceptance test:
 - a. All approved and signed-off test forms.
 - b. Final Punch List.
 - c. Certification of completion of all punch list items.
 - d. System Warranty Certificate and Start Date

1.5 QUALITY ASSURANCE

- A. Test personnel:
 - 1. Furnish qualified technical personnel to perform all calibration, testing, and verification. The test personnel are required to be familiar with this Project and the equipment, software, and systems before being assigned to the test program.

1.6 SCHEDULING

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 INSTALLATION

- A. As specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Installation supervision:
 - 1. Provide as specified in Section 40 60 00 - Common Work Results for Process Control and Instrumentation Systems.

3.2 COMMISSIONING

- A. Commissioning as specified in the Contract Documents.
- B. Testing and training phase:
 - 1. Source testing:
 - a. Manufacturer services: Provide as specified in the table below.

Section Number	Section Title	Source Testing (Witnessed or Non-Witnessed)
40 61 96 - Control Strategies	Control Strategies	Witnessed
40 67 00 - Control Systems - Panels, Enclosures, and Panel Components.	Control Systems - Panels, Enclosures, and Panel Components	Witnessed
40 80 00-Commissioning for Instrumentation and Controls	Commissioning for Instrumentation and Controls	Witnessed

- b. Prerequisite requirements:
 - 1) ENGINEER approval of the hardware and equipment source testing submittal, Manufacturer Certificate of Source Testing, is required before proceeding to Preliminary FAT.
- c. Preliminary FAT (Pre-FAT):
 - 1) The purpose of the Pre-FAT is to provide assurance that the HMI/SCADA system is ready for the full, witnessed FAT, in terms of both stability and functionality.
 - a) Debugging of software and troubleshooting of hardware shall occur during and before the pre-FAT, not during the FAT.
 - b) Contractor shall fully test the HMI/SCADA system and fix all deficiencies found before the FAT.
 - 2) Conduct utilizing test procedures approved by ENGINEER
 - 3) OWNER shall have the right to witness any or all of the Pre-FAT testing and shall be notified in writing 20 days before the start of the pre-FAT.

- 4) Submit a letter, signed by the Contractor's project manager or company officer, certifying that integrated system hardware and software has been tested and confirmed to be fully operational and in compliance with the requirements specified in the Contract Documents and is fully ready for the full, witnessed FAT.
 - a) Attach the completed pre-FAT test forms, signed by the Contractor's staff.
- 5) ENGINEER approval of the pre-FAT submittal is required before proceeding to FAT.
- d. FAT hardware and communications testing:
 - 1) Perform tests to show that the integrated system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
 - 2) The complete PCIS system including operator stations, servers, network equipment, printers, PCMs, PLCs, RTUs, LCPs, CCS, peripherals, communications equipment, and other HMI/SCADA equipment, shall be assembled, connected, and software loaded for a fully functional FAT of the integrated system.
 - 3) Testing simulation:
 - a) Inputs and outputs shall be simulated and proper control and system operation shall be validated.
 - b) FAT shall make use of simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, which shall be connected to the I/O points within the HMI/SCADA system.
 - (1) The use of jumper wires, terminal block mounted pilot lights, and loose meters to act as or supply the functionality of a simulator shall not be allowed.
 - (2) The simulator may consist of a PLC, operating under an HMI/SCADA software package, or other approved software that has its I/O points wired to PLC's I/O points.
 - (3) Software operating on a PC may then act as the switches, pilot lights, variable analog signal generators, and analog signal level displays.
 - 4) Additional source tests are specified in other sections of the Instrumentation and Control Specifications.
 - 5) OWNER shall have the right to witness any or all of the FAT testing and shall be notified in writing 20 days before the start of the FAT.
 - 6) Verify communications between the hardware and the programmer's software comply with specified requirements.
 - a) For systems that contain RTUs or remote communications with other devices, the complete communications system must be factory tested, including actual interfacing with telephone company

equipment and/or the actual radios used for radio based telemetry systems.

- 7) Panel inspections:
 - a) ENGINEER will inspect each control panel for completeness, workmanship, fit and finish, and compliance with the Contract Documents and the accepted shop drawings.
 - (1) Inspection to include, as a minimum: Layout, mounting, wire and data cable routing, wire tags, power supply, components and wiring, I/O components layout (including terminals, wiring and relays), device layout on doors and front panels, and proper ventilation operation.
 - b) Inspection forms:
 - (1) Provide panel inspection forms as part of the FAT procedures submittal.
 - (2) A sample FAT control panel form has been provided at the end of this Section.
- 8) I/O test:
 - a) ENGINEER will verify that I/O is properly wired to field terminals and is properly mapped into the PLC and the rest of the SCADA system, including all operator interface devices.
 - b) Test methodology:
 - (1) Discrete inputs:
 - (a) Apply appropriate input from simulator at panel terminal, observe input card indicator, observe data value at each indicated data address, and observe data received at field wiring terminals or operator interface screen.
 - (2) Discrete outputs:
 - (a) Issue commands from operator interface screen or PLC, verify output card indicator light, and measure response at field wiring terminals or multimeter.
 - (3) Analog inputs:
 - (a) Apply appropriate analog input signal at panel terminals on simulator, observe data value at each indicated data address, and observe data properly received at field wiring terminals or operator interface screen.
 - (b) Check each point at 0 percent, 50 percent, and 100 percent of scale.
 - (4) Analog outputs:
 - (a) Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response at field wiring terminals or multimeter.
 - (b) Check each point at 0 percent, 50 percent,

and 100 percent of scale.

- c) Test forms to include, but not be limited to the following data:
 - (1) PLC and panel number.
 - (2) I/O type.
 - (3) I/O tag name.
 - (4) Rack/slot/number of I/O point.
 - (5) Check-off for correct response for each I/O point.
 - (6) Comments field.
 - (7) Initials of individual performing test.
 - (8) Date test was performed.
 - (9) Witness signature lines.
- 9) System configuration test:
 - a) Demonstrate and test the setup and configuration of operator stations, servers, development stations, and peripherals.
 - b) Demonstrate utility software and functions, such as virus protection, backup, optical drive burning, network monitoring, etc.
 - c) Demonstrate the proper operation of peripheral hardware.
 - d) Demonstrate general HMI/SCADA functions.
 - e) Demonstrate proper operation of log-on and other security access functions.
 - f) Demonstrate the proper operation of all historical data storage, trend, display, backup, and report functions.
 - g) Test automatic fail over of redundant equipment.
 - h) Demonstrate the proper operation of the alarm display and acknowledgement functions.
 - i) Test forms:
 - (1) For each test, list the specification page and paragraph of the function demonstrated, and provide a description of the function.
 - (2) List the specific tests and steps to be conducted.
 - (3) For each function, list all of the different sub-functions or ways the function can be used, and provide a test check-off for each:
 - (a) Include signature and date lines.
- 10) ENGINEER approval of the FAT Communication Testing activities is required before proceeding to FAT Platform Testing.
- e. FAT Platform Testing - Control logic test:
 - 1) Verify the PLC, HMI and SCADA, provides monitoring and control functionality based upon specified and designed control requirements.
 - 2) Testing requirements:
 - a) Demonstrate each function described in the Control Strategies.
 - b) Demonstrate in detail how each function operates under

- a variety of operating scenarios.
 - (1) Test to verify the application of each general control strategy function to each specific control strategy or loop description.
 - c) Demonstrate the proper operation of the programming and configuration for each control strategy or loop description.
 - (1) Test each strategy or loop description on a sentence by sentence and function by function basis.
 - (2) Loops with similar or identical logic must each be tested individually.
 - (3) Test the boundaries of each numeric operator input by entering values outside of the allowable range.
 - d) Demonstrate the proper operation of all digital communication links and networks.
 - (1) Verify each digital communication I/O point.
 - e) Failure testing: Demonstrate how the system responds to and recovers from abnormal conditions including, but not limited to: equipment failure, operator error, communications subsystem error, communications failures, simulated/forced software lockups, power failure (both utility power and power to HMI and/or SCADA hardware), process equipment failure, and high system loading conditions.
 - 3) Test forms:
 - a) Submit completed test forms for each loop including but not limited to the fully revised and approved control strategy.
 - b) Identify the cause and effect as each I/O point is toggled through the simulator.
 - (1) Identify and track proper and/or improper operation of the loop.
 - c) Note any deficiencies or operational changes on the forms for correction and documentation:
 - (1) Include signature and date lines.
 - 4) ENGINEER approval of the FAT submittal is required prior to shipment of system components.
2. OWNER training:
- a. Demonstration requirements are specified in this Section. Provide OWNER training customized to the systems provided on a given project. The following table and descriptions list the possible training types for a given project. Every project will require System Overview and Operator Training of the minimum amounts listed below. More complex projects will require additional training as requested by the OWNER or ENGINEER.

Table 1			
Course Title	Minimum Course Length (hours per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
System Overview	4	10	1
Operator Training - Basic	1	10	1
Operator Training - Advanced	1	10	1
CIS (Computer) Equipment Maintenance	1	10	1
HMI Software	1	10	1
Historian System Training	1	10	1
Reports Training	1	10	1
PLC Hardware	1	10	1
PLC Software	1	10	1
LOI Hardware and Software	1	10	1
Network Equipment	1	10	1
Follow-Up Training	1	10	1
Instrument Training	1	10	1

3. Training course requirements:
 - a. System overview training:
 - 1) Furnish training courses that give the OWNER's supervisory level personnel and overview of all elements of the PCIS system that focus on the overall functional aspect of elements of the control system and provide an understanding of the interaction of the various components.
 - 2) Furnish a training course that gives the OWNER's supervisory level personnel and overview of the new Contractor-provided elements of the PCIS system. Focus on the overall functional aspects of each new elements of the control system, particularly the mechanical system vendor-provided control packages.
 - b. Operator training:
 - 1) Furnish training courses that instruct system operators in the efficient operation of all aspects of the PCIS that include not only the general operation of the control system but also the operation of specific system features.
 - 2) Furnish training courses that instruct system operators in the efficient operation of Contractor-provided aspects of the PCIS that include not only the general operation of each control system but also the operation of specific system features.
 - 3) Operator's training shall include the following for each vendor

package and programmable device:

- a) Control system overview: Architecture, equipment functions, software components, etc.
 - b) Changes made to existing systems.
 - c) Display navigation, overview, and types of displays.
 - d) Process and equipment monitoring and control: Basic principles and operation.
 - e) Logging ON and OFF the system and description of the security and access system.
 - f) Alarm subsystem.
 - g) Trending: Provide a thorough session on how to use all trending functions.
 - h) Reports: How to access, print, and review content.
 - i) Control strategies: Present an average 15-minute review of each control strategy, including a hands-on demonstration of screens and operator functions for each.
 - j) Instruction on the use of all operational functionality alarm logging, trending, displays, database, reports, and control software developed for the Project and incorporated in the installed PCIS system.
- c. PCS computer equipment maintenance training:
- 1) Furnish training courses that will enable maintenance technicians to perform troubleshooting and repair of all system computer equipment. Include the theory of operation of the system as a whole, including related operating system and utility software.
- d. HMI software training:
- 1) Furnish training courses that will enable the OWNER's staff to develop and maintain all aspects of the operator interface system applications.
 - 2) Include topics:
 - a) Operating systems and utilities such as virus protection software.
 - b) Point (tag) database development and modification.
 - c) Graphic screen creation and editing.
 - d) Scripting.
 - e) I/O servers, drivers, etc.
 - f) PLC interface functions and software.
 - g) Displays, scripts conventions, and documentation.
 - h) Trending.
 - i) Alarms and events.
 - j) System security, access levels, and areas of responsibility.
 - k) General system maintenance, including backups, history data archive, version control, file naming and cataloging conventions, and system file housekeeping.

- 3) Address not only the procedures associated with the control system's standard software packages, but in addition include material explaining the specific conventions used in developing the Project's system applications (graphics, PLC/RTU interface, scripts, control strategies, trends, etc.). In addition, provide instruction in the use of techniques for developing and maintaining current, comprehensive documentation for all installed system applications.
- e. Historian system training:
 - 1) Furnish the following training:
 - a) Introduction to relational databases.
 - b) Introductory training on the specific relational database program used for the historian server.
 - c) How to set up points for historian logging.
 - d) How to develop, edit, and print custom reports, in detail.
 - e) Introduction to use of the query language.
 - f) System maintenance.
 - g) Interface to networks outside of the control system.
 - f. Report training:
 - 1) Furnish training courses that will enable the OWNER's staff to develop and maintain all aspects of reports.
 - 2) Include topics:
 - a) Generation of a developed report.
 - b) Generation of a new report.
 - c) Modification and editing of reports.
 - d) Formatting reports.
 - e) Manual entry and automatic entry of data from a database.
 - g. PLC hardware training:
 - 1) Furnish training on PLC hardware and on related components, including battery backup equipment, UPSs, LOI hardware, control circuits, and analog circuits.
 - 2) Furnish training on PLC hardware principles, product features, proper installation, operation, troubleshooting, and maintenance.
 - 3) PLC training may be provided by manufacturer's certified trainers.
 - h. PLC software training:
 - 1) Furnish training on PLC software.
 - 2) 2 types of training are required, basic and project-specific:
 - a) Basic PLC software training covers the principles of PLC programming and the specific features and function of the PLC products used on this Project, provided by one of the PLC manufacturer's certified trainers.
 - b) Project-specific PLC software training covers the programming conventions, new standardized software modules, specific control strategy programs, and documentation created for the Work performed under this Contract. This training includes the specific

knowledge needed to modify, expand, duplicate, troubleshoot, and repair the PLC programs provided under this Contract, provided by a qualified member of the ICSC who is thoroughly familiar with the delivered system, and is one of the senior programmers who programmed the PLCs for this Project.

- i. LOI hardware and software training:
 - 1) Provide the following:
 - a) Overview of hardware and firmware, including starting, stopping, and PLC interface.
 - b) Configuration of tag database.
 - c) Creating, editing, and saving display screens.
 - d) Troubleshooting.
- j. Network equipment training:
 - 1) Furnish basic training on all network hardware, switch and router configuration and software, and network monitoring software.
 - 2) Include a detailed description and explanation of the installed network architecture, media, and functions.
 - 3) Furnish an overview of the function and operation of each piece of network equipment.
 - 4) Furnish training on network maintenance troubleshooting and repair.
 - 5) Furnish training on how to install spare or off-line backup equipment.
 - 6) Basic network overview:
 - a) Discuss a basic network overview for each site.
 - b) Discuss the architecture (loop, star, etc.), media redundancy, and items that are not readily apparent to staff.
 - c) Discuss how to monitor the network health through the HMI network screen.
 - d) Discuss both enterprise level networks, the PCS communications network, and the field network.
 - 7) Ethernet switches:
 - a) Discuss the various types of switches (Layer 2, Layer 3, etc.).
 - b) Discuss switch health monitoring through the HMI.
 - c) Discuss the VLAN configuration (what ports should be used for what network, etc.).
 - d) Discuss testing procedures.
 - 8) Field networks:
 - a) General:
 - (1) Discuss general principles behind likely device failures and actions to take to resolve such failures for each type of field network.
 - b) DLR networks:
 - (1) Discuss how to add non-DLR equipped devices to a DLR network.

- (2) Discuss how to monitor and test DLR network health through an ETAP module or DLR capable switch.
 - 9) Wireless networks:
 - a) Discuss parameters specific to wireless networks including, but not limited to: remote resetting options, bandwidth availability, channel speed, and ultimate channel capacity.
- k. Follow-up training:
 - 1) Provide a series of on-site follow-up training classes beginning after process start-up of the SCADA/PCIS system. The intent for these classes is to provide the OWNER's personnel the opportunity for a review and "refresher" of the training topics and material after they have had some experience using the system.
 - 2) Mutually schedule and develop the content of these classes with the OWNER no later than 1 month before the beginning of the first session:
 - a) Schedule at the OWNER's discretion on non-consecutive days spaced out over the process start-up and warranty period.
- l. Instrumentation training:
 - 1) Furnish training covering all instruments and control panels.
 - 2) Furnish the specified quantity of training, allocated to cover new instruments and hardwired controls as specified in this Section and specifically determined in the accepted training plan.
 - 3) Train maintenance staff in the use, cleaning, calibration, maintenance, and troubleshooting of all the instruments furnished within this Project.
 - 4) Furnish training on the operation of new hardwired controls.
- m. Analytical instrument training:
 - 1) Furnish training covering all analytical instruments.
 - 2) Furnish the specified quantity of training, allocated to cover new analytical instruments as specified in this Section and specifically determined in the accepted training plan.
 - 3) Train maintenance staff in the use, cleaning, calibration, maintenance, and troubleshooting of all the analytical instruments furnished within this Project.
 - 4) Provide training by manufacturer.
- 4. Recording training sessions:
 - a. Record all training.
 - b. Produce audio-visual presentations by recording the actual training sessions of the OWNER's personnel.
 - c. Furnish digital video disk (DVD) format.
 - d. These disks become the property of the OWNER and cover, in detail, the training for the specific hardware and software of all the systems provided for the Project.
 - e. Provide all the necessary cameras and recording equipment.

5. Installation testing:
 - a. Calibration:
 - 1) Performed by Contractor and ICSC.
 - 2) Calibrate and adjust all instruments, devices, valves, and systems, in conformance with the component manufacturer's instructions and as specified in these Contract Documents.
 - 3) Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
 - a) Calibration for discrete devices:
 - (1) Calibrate and adjust devices for reliable operation and to avoid nuisance tripping.
 - b) Calibration for ultrasonic and radar level devices:
 - (1) Provide Echo Transmission and signal quality on level transmitters including guided and unguided units.
 - (a) Submit printout of the actual transmission and parameters.
 - (2) Adjust mounting, as required, to obtain accurate readings.
 - (3) Post mounting: Provide any additional calibration required by manufacturer.
 - c) Calibrating analog transmitters:
 - (1) Components having adjustable features are to be set accurately for the specific conditions and applications of this installation.
 - (2) Test and verify that components and/or systems are within the specified limits of accuracy.
 - (3) Calibration points:
 - (b) Calibrate each analog instrument at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, using test instruments with accuracies traceable to NIST.
 - (4) Field verify calibration of instruments including units that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
 - d) Analyzer calibration:
 - (1) Calibrate and test each analyzer system as a workable system after installation. Follow the testing procedures directed by the manufacturers' technical representatives.
 - (2) Submit completed instrument calibration sheets for every field instrument and analyzer.
 - (3) Calibration tags:
 - (a) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
 - (b) Sign the tag when calibration is complete.
 - e) Calibration for industrial networking test equipment:

- f) Submit calibration documentation.
- b. Loop check:
 - 1) Performed by the Contractor.
 - 2) Cabling installed, terminated, and labeled.
 - 3) Perform continuity check of wiring to each field device through intermediate devices to field terminals in the cabinet.
 - 4) Complete loop check form for each device.
 - 5) Submit loop check test results before proceeding to the next step.
- c. Loop validation tests:
 - 1) Performed by the Contractor, ICSC, and manufacturer's representative, working together, and witnessed by the OWNER or OWNER's representative.
 - 2) Perform tests on the signal from each field device through intermediate devices to the I/O module on the PLC.
 - a) The PLC may or may not be connected to the network.
 - 3) ENGINEER approval of the loop validation test submittal is required before proceeding to CEET.
- d. LAN cable post-testing:
 - 1) Performed by Contractor and ICSC.
 - 2) After installing the cable and connectors, test all cables using the LAN certification to confirm the installation meets the requirements of the specification.
 - 3) Provide test documentation that includes the cable number, total length of cable, a permanent hard copy, as well as a USB or CD copy of all traces.
 - a) After installing connectors:
 - b) Perform cable end-to-end testing on all installed cables from both ends of the cable. Test shall include cable system performance tests and confirm the absence of wiring errors.
 - c) Submit a signed test report presenting the results of the cable testing.
 - d) Repair or replace any portions of the system not meeting TIA/EIA standards for installed cabling. Repaired sections shall be retested.
 - 4) Submit final documentation (including traces), using the approved test form, to the ENGINEER upon successful completion of the testing.
 - 5) ENGINEER approval of the LAN cable post-testing submittal is required before proceeding to CEET.
- e. Complete End-to-End Testing (CEET):
 - 1) Performed by Contractor, ICSC, and manufacturer's representative working together, with assistance from the OWNER or the inspection staff, as needed.
 - a) The participants need to be dedicated full-time to CEET.
 - b) ICSC will provide staff to verify input signals at, and

- create output signals from, an HMI or engineering Workstation.
 - c) Contractor and ICSC will be responsible for creating field signals and verifying proper operation of final control elements.
- 2) Prerequisites:
 - a) CEET cannot begin until the successful completion of the preceding tests:
 - (1) Calibration.
 - (2) Loop check.
 - (3) Loop validation tests.
 - (4) LAN cable post-testing.
 - (5) Industrial network testing.
- 3) Testing description:
 - a) This testing is to ensure all I/O signals operate to the intent of the design from the field device to the HMI and all other auxiliary controls and indicators in the PCS.
 - b) Connect PLC to the network to test signals from the field device through the PLC program, the network, and to the operator's HMI graphic screens. The outputs will be energized for a duration long enough to verify proper operation of the final control element.
 - c) SCADA screens:
 - (1) Test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
 - (2) For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.
 - (3) Retest any loop following any necessary corrections.
- 4) Check control loops under simulated operating conditions by causing a range of input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the HMI/SCADA system.
 - a) Use actual process inputs wherever available.
 - b) Issue commands from the HMI/SCADA system and verify proper responses of field devices.
 - (1) Test SCADA system inputs from field device to SCADA system operator workstations.
 - (a) Track responses through trend charts in the HMI/SCADA system.
 - (2) Test SCADA system outputs from SCADA operator workstations to field devices and equipment.
- 5) Discrete device testing:
 - a) Exercise each field device providing a discrete input to the HMI/SCADA system in the field and observe the

proper operation shall be observed at the operator workstation:

- (1) Test limit switches, set limits mechanically, and observe proper operation at the operator workstation.
 - (2) Exercise starters, relay contacts, switch contacts, and observe proper operation.
 - (3) Calibrate and test instruments supplying discrete inputs, and observe proper operation.
- b) Test each device accepting a discrete output signal from the HMI/SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device:
 - (1) Stroke valves through outputs from the HMI/SCADA system, and confirm proper directional operation. Confirm travel limits and any feedback signals to the HMI/SCADA system.
 - (2) Exercise motors starters from the HMI/SCADA system and verify proper operation through direct field observation.
 - (3) Exercise solenoids and other field devices from the HMI/SCADA system and verify proper operation through direct field observation.
- 6) Analog device testing:
 - a) Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
 - b) Apply provisional settings on controllers and alarm setpoints.
- 7) Analog input:
 - a) Exercise each field device monitoring the analog signal, through the HMI/SCADA system.
 - (1) Apply simulated sensor inputs corresponding to 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span for networks that incorporate analog elements, and monitor the resulting outputs to verify compliance to accuracy tolerance requirements.
- 8) Analog output:
 - a) Exercise each field device requiring an analog command signal, through the HMI/SCADA system.
 - (1) Vary the output from the PLC HMI/SCADA system and measure the end device position, speed, etc. to confirm the proper operation of the device for the supplied analog signal.
 - (2) Manually set the output from the HMI/SCADA screen at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent and measure the response at the final device and at any

intermediate devices.

- 9) Submit completed test forms.
 - a) Discrete instrument input devices:
 - (1) Switch setting, contact action, and dead band.
 - (2) Valve position switches:
 - (a) Response in the PLC as the valve is stroked from the PLC.
 - (b) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
 - (3) Operator interface switches (control stations and other pilot devices) and associated response.
 - (4) Starter and drive auxiliary device contact response.
 - (5) Response of all other discrete inputs to the PLC.
 - (6) Test equipment used and associated serial numbers.
 - b) Discrete output devices:
 - (1) Observed response of field device to the discrete output from the PLC.
 - (2) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
 - (3) Test equipment used and associated serial numbers.
 - c) Analog input devices:
 - (1) Calibration range.
 - (2) Calibration data: Input, output, and error at each test value.
 - (3) Analog input associated PLC register address.
 - (4) Value in PLC register at each test point.
 - (5) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
 - (6) Test equipment used and associated serial numbers.
 - d) Analog output devices:
 - (1) Calibration range.
 - (2) Test value at each test point.
 - (3) Analog output associated PLC register address.
 - (4) Control variable value at field device at each test point.
 - (5) Physical device response at each test point:
 - (6) Response to be actual valve position, or motor speed, etc.
 - (7) Test equipment used and associated serial numbers.
- 10) Failure testing:
 - a) Demonstrate how the system reacts and recovers from

abnormal conditions including, but not limited to:

- (1) Equipment failure.
- (2) Communications sub-system error.
- (3) Power failure.
- (4) Process equipment failure.
- (5) High system loading conditions.

11) ENGINEER approval of the CEET submittals is required before proceeding to Functional Testing.

6. Functional testing:

a. General:

- 1) Testing to demonstrate proper operation of systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
- 2) Performed by Contractor, ICSC, and manufacturer's representative working together, with assistance from the OWNER or the inspection staff, as needed.
- 3) Additional tests are specified in other Instrumentation and Control Sections.
- 4) Follow approved detailed test procedures and check lists for Functional Test activities.

b. Control logic operational validation:

- 1) The purpose of control logic validation is to field test the operation of the complete control system, including all parts of the HMI/SCADA system, all control panels (including vendor control panels), all control circuits, all control stations, all monitored/controlled equipment, and final control elements.
- 2) Demonstrate control functionality shown on the P&IDs, control schematics, and other drawings, and specified in the loop descriptions, control strategies, Electrical Specifications, and Mechanical Equipment Specifications.
- 3) Test in detail on a function-by-function and sentence-by-sentence basis.
- 4) Thoroughly test hardware and software functions:
- 5) Including all hardwired and software control circuit interlocks and alarms.
- 6) Test final control elements, controlled equipment, control panels, and ancillary equipment under startup, shut down, and steady-state operating conditions to verify all logic and control is achieved.
- 7) Control logic validation tests to include, but not limited to: a repeat of all control logic tests from the FAT, modified and expanded to include all field instruments, control panels, circuits, and equipment.

c. Loop tuning:

- 1) Optimally tune all electronic control stations and software control logic incorporating proportional, integral, or derivative control. Apply control signal disturbances at various process variable levels and adjusting the gain, reset, or rate settings as required to achieve proper response.

- 2) Verify the transient stability of final control elements operating over the full range of operating conditions, by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates. As a minimum, achieve 1/4-wave amplitude decay ratio damping (subsidence ratio of 4) under the full range of operating conditions.
- 3) If excessive oscillations or system instability occur, as determined by the ENGINEER, continue tuning and parameter adjustments, or develop and implement any additional control algorithms needed to achieve satisfactory control loop operation.
- 4) Functional validation sheets:
 - a) Document each Functional test on an approved test form.
 - b) Document loop tuning with a report for each loop, including two- pen chart recordings showing the responses to step disturbance at a minimum of 3 setpoints or process rates approved by the ENGINEER. Show tuning parameters on the charts, along with time, date, and sign-off by Contractor and ENGINEER.
 - c) Include on the form, functions which can be demonstrated on a loop-by-loop basis:
 - (1) Loop number and P&ID number.
 - (2) Control strategy, or reference to specification tested.
 - (3) Test procedures: Where applicable, use the FAT function- by-function, sentence-by-sentence loop test checklist forms modified to meet the requirements of the Functional test. Otherwise, create new forms.
 - d) For functions that cannot be demonstrated on a loop-by-loop basis (such as overall plant power failure), include on the test form a listing of the specific steps and tests to be conducted. Include with each test description the following information:
 - (1) Specification page and paragraph of function demonstrated.
 - (2) Description of function and/or text from specification.
 - (3) Test procedures: use the FAT loop test checklist forms modified to meet the specific testing conditions of the Functional test.
- 5) Functional certification:
 - a) Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01 91 00 - Commissioning.
 - (1) Including all test forms with test data entered,

submitted to the ENGINEER with a clear and unequivocal statement that all Functional test requirements have been satisfied.

C. Process Start-up Phase:

1. Process Start-up:
 - a. ICSC shall be onsite to support Process Start-up activities and provide functional changes as required.
2. Process Operation Period:
 - a. ICSC shall be available to support Process Operational Period and provide functional changes as required.
3. Instrumentation and Controls Fine-Tuning:
 - a. General:
 - 1) After the Process Operational Period, test PCIS system for additional 60 days as specified in this Section to identify issues and make corrections, as needed.
 - 2) The performance test is part of the Work that must be completed as a condition of substantial completion and final completion for the entire Project.
 - 3) The complete PLC control and HMI/SCADA system must run continuously for the duration of the performance test.
 - 4) Test and use the entire process control system under standard operating conditions.
 - 5) Exercise all system functions.
 - 6) Log failure, any system interruption and accompanying component, subsystem, or program failure including time of occurrence, duration of each failure, failure classification, and cause:
 - a) Provide a competently trained technician or programmer on call for the Project Site during all normal working days and hours from the start of the performance test until final acceptance of the system.
 - (1) Response time to the Project Site: 24 hours or less, for a major failure.
 - b. SCADA system testing:
 - 1) Exercise each system function, e.g., status report, alarms, logs, and displays several times at a minimum, and in a manner that approximates "normal" system operation.
 - 2) Failure of the HMI/SCADA system during testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications.
 - a) Corrective action is required before restarting the performance test.
 - 3) Only those components, sub-systems, and systems covered in this Section and supplied under this Contract shall be considered for this acceptance test. Problems and failures of other systems shall not be considered as part of this test, except as they display the capabilities of this system to detect failures.
 - 4) Failures:

- a) Classify failures as either major or minor:
 - (1) Minor failure:
 - (a) A small and non-critical component failure or software problem that can be corrected by the OWNER's operators.
 - (b) Log this occurrence but this is not a reason for stopping the test and is not grounds for non-acceptance.
 - (c) Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.
 - (d) Failure of one printer or operator station is considered a minor failure providing all functions can be provided by backup equipment, i.e., alternate printers and operator station, and repairs can be made and equipment returned to service within 3 working days.
 - (2) Major failure:
 - (a) Considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
 - (b) Cause termination of the performance test.
 - (c) Start a new acceptance test when the causes of a major failure have been corrected.
 - (d) A failure is also considered major when failure of any control system that results in an overflow, underflow, overdose, or underdose condition occurs.
- 5) Technician report:
 - a) Each time a technician is required to respond to a system malfunction, they must complete a report, which includes details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.
 - b) If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report is required or logged as specified above.
 - c) If a technician has performed work but no report is written, then a major failure is considered to have occurred.
 - d) Each report shall be submitted within 24 hours to the ENGINEER and the OWNER, or its representative.

3.3 SCHEDULES

A. Example test forms:

1. Example test forms are attached at the end of this Section. They may be used as a starting point for the development of Project-specific test forms for this Project.
2. The example test forms are not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

+ + END OF SECTION + +

SECTION 43 23 00

DRY LOCATION LIQUID PUMPS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install a Dri-Prime Back-up System complete and operational. The Contractor unless otherwise required in this specification section, shall supply discharge piping, piping supports, as well as control panels, valves, anchor bolts, gauges and other specialties. Pump suction pipe, if shown in the drawings, shall also be supplied by the Contractor. All performance and warranty requirements shall also be the responsibility of the approved manufacturer.
2. Included are motors, pumps, drives, housings, propellers, and control panel.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the Dri-Prime Back-up System Work.

C. Related Sections:

1. Section 01 65 00, Product Delivery Requirements.
2. Section 01 78 23, Operation and Maintenance Data.
3. Section 05 05 33, Anchor Systems.
4. Section 40 61 96, Control Strategies

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. ANSI B16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:

1. Obtain all equipment included in this Section regardless of the component manufacturer from a single Diesel Pump manufacturer.
2. The Diesel Pump manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this specification.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the Diesel Pump manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Manufacturer's literature, illustrations, specifications, and engineering data including materials, dimensions, weights, performance data, and part lists for all components in sufficient detail to allow an item by item comparison with the Contract Documents.
 - b. Bill of material for all equipment and spare parts.
 - c. Electrical wiring and interconnection diagrams with all external connections identified.
 - d. Control panel data shall include:
 - 1) Description of control features.
 - 2) Operator panel control switches and functions.
 - 3) Alarm and status displays.
 - 4) Provisions for remote start signal and remote status and alarm.
 - 5) Compliance with UL 508.
 - e. Enclosure data shall include the following:
 - 1) Plan and elevation drawings showing overall dimensions, interior equipment arrangement, and working spaces.
 - 2) Construction details and hardware specifications.
 - 3) Exhaust piping and silencer mounting arrangement.
 - 4) Sound attenuation provisions and decibel levels.
 - f. Fuel storage system data shall include:
 - 1) Storage tank arrangements.
 - 2) Storage capacity and hours of operation at rated load.
 - 3) Alarm devices.
 - 4) Construction details including secondary containment provisions for fuel tank.
 - 5) Piping arrangements and details.
 - 6) Compliance with UL 142 and local codes.
 - g. Provide the following relative to installation:
 - 1) Vibration isolators and anchor bolt requirements.
 - 2) Seismic restraint requirements.
 - 3) Provisions for fuel piping, electrical conduits, and other external connection requirements.
 - h. Drawings and information for control panels and instruments per this Section, Section 40 61 96, Control Strategies. This includes submittal of panel wiring drawings, hardware, circuit breakers, motor starters, and electrical devices furnished.
 - i. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
 - j. List of deviations from the Contract Documents.
 - k. Listing of conveyor components and materials.
 - l. Provide a copy of the manufacturer's standard warranty for parts and labor.
- h. For all components of a Diesel Pump as appropriate, including setting drawings and instructions for installation of anchor bolts and gear reducer, including tolerances.

B. Informational Submittals: Submit the following:

1. Support Design Information:
 - a. Weight of the complete assembly.

- b. Certificates
 - 2. Source Quality Control Submittals:
 - a. Submit results of performance tests and cable insulation tests.
 - b. Submit results of required control panel shop tests.
 - 3. Site Quality Control Submittals:
 - a. Submit a written report giving the results of required field tests.
 - b. Submit written report of results of each visit by a manufacturer's serviceman, including purpose and time of visit, tasks performed and results obtained.
- C. Closeout Submittals: Submit the following:
 - 1. Operation and Maintenance Manuals:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts:
 - a. Furnish all required spare parts as specified in Part 2 of this specification.
 - 2. Tools:
 - a. Furnish all required special tools as specified in Part 2 of this specification.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Comply with Section 01 65 00, Product Delivery Requirements.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

- A. Description:
 - 1. Provide one (1) DriPrime Diesel Back Up Pump System. The permanent skid mounted trash pump specified in this section will be used to pump raw sewage. Pump shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing. The pump and accessories shall be supplied by the pump manufacturer. The pump offered shall be the manufacturer's standard production model. It shall have been in continuous use by municipal and industrial owners for a minimum of five years. A list of five user contacts including

contact names and telephone numbers shall be provided with the bid submittal. Failure to supply a verifiable users list will be cause for rejection of the bid.

B. Performance Criteria:

1. Schedule of Service Conditions:
 - a. Operating speed (maximum): 2200 RPM
 - b. Maximum solids handling size: 3.125 inches
 - c. Impeller diameter: 290 mm
 - d. Suction size: 8 inches
 - e. Discharge size: 8 inches
 - f. Maximum suction lift: 28 feet

2.2 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:

1. Godwin Dri-Prime® CD225M
2. Or Approved equal.

2.3 DETAILS OF CONSTRUCTION

A. DriPrime Diesel Pump:

1. Casing, Suction Cover, Separation Tank: Pump castings shall be cast iron. Pump design shall incorporate a direct suction flow path that is in axial alignment with the impeller eye. There shall be no turns, chambers or valves between the suction flange and the impeller eye.
2. Impellers: The pump impeller shall be an open, 3-bladed, non-clog type with pump out vanes on the back shroud and fabricated from cast steel construction (minimum Brinell Hardness 200 HB).
3. Wearplates: Shall be fully adjustable and replaceable, fabricated of high chromium cast iron. Wearplate clearances shall have no relationship to the ability of the pump to achieve a prime.
4. Bearings and Shafts: Pump shall be fitted with a bearing bracket to contain the shaft and bearings. Bearings shall be tapered roller bearings of adequate size to withstand imposed loads for sustained pumping at maximum duty points. Minimum ISO L10 bearing life to be 100,000 hours. Impeller shafts shall be fabricated of 1.5% chromium alloy.
5. Seals: Seals shall be high pressure, mechanical self-adjusting type with silicon carbide faces capable of withstanding suction pressures to 73 psi. The mechanical seal shall be cooled and lubricated in an oil bath reservoir, requiring no maintenance or adjustment. Pump shall be capable of running dry, with no damage, for periods up to 24 hours. All metal parts shall be of stainless steel. Elastomers shall be Viton.
6. Pump Suction and Discharge Flanges: Shall be cast iron ANSI (B16.1) Class 150, flat faced.
7. Pump Gaskets: Shall be compressed fiber and/or Teflon.
8. Pump O Rings: Shall be Viton

9. Priming System: Automatic priming system incorporates a twin-cylinder compressor and air ejector assembly, no vacuum pump shall be considered. The compressor shall be installed on the engine auxiliary drive and shall be gear driven, lubricated and cooled from the engine. The priming system shall require no fail-safe protection float gear or any adjusting at high or low suction lifts. Pumps with self-priming chambers modified with vacuum priming systems shall not be accepted as equal. The pump must be capable of running totally dry for periods up to 24 hours, then re-priming and returning to normal pumping volumes. Pump and priming system is capable of priming the pump from a completely dry pump casing. The pump shall be capable of static suction lifts to 28 vertical feet, at sea level. It shall also be capable of operation using extended suction lines. Equipment acceptance shall be contingent upon the pump's ability to run continuously at full speed in a completely dry condition for periods up to 24 hours. The engineer may require a demonstration.
10. Check Valve: Pump shall be supplied with an integral swing type check valve mounted on the discharge of the pump allowing unrestricted flow from the impeller. The check valve shall prevent in-line return of flow when the pump is shut off. Non-return valve elastomers shall be Nitrile rubber and shall be field replaceable.

B. Engine Unit:

1. Drive Unit: The drive unit shall be a diesel water-cooled engine. The engine shall drive the pump by use of direct connected intermediate drive plate. Starter shall be 12 volt electric. Safety shut down switches for low oil pressure and high temperature shall be integral to the engine control panel. Battery shall have 180-amp hour rating. The engine control panel shall include a tachometer and an hour meter. Drive unit shall be a John Deere 4045HF280 or equal, rated at 99 hp at 2400 RPM. A certified continuous duty engine curve shall be supplied to the owner/engineer.
2. Engine coolant heaters, thermostatically controlled, capable of keeping jacket water at temperature not less than 90 degrees F. Coolant heaters shall operate at 120 volts, single phase. House contactor for controlling heater in NEMA 4X stainless steel enclosure mounted on unit.
3. Engine Control Panel: Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds in manual mode. See section 2.3 for Automatic mode.
4. Fuel Source: Fuel tank capacity shall be sufficient to provide at least twenty-four hours of operating time at system duty. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.
5. Exhaust: Exhaust system shall include a critical grade muffler of suitable size. Exhaust system shall have muffler and exhaust tubing sized to match maximum engine exhaust flow without exceeding engine manufacture's maximum allowable back pressure values
6. Starting System: DC system complete with engine mounted batteries, locally mounted charger and connecting cables between batteries and engine and

between charger and batteries.

- a. Batteries: Lead-acid or calcium/lead antimony, engine cranking type, rated in accordance with engine manufacturer's requirements for minimum of three 15-second cranking cycles at firing speeds without recharging, and to accommodate DC power requirements of control panel and other accessories requiring DC power.
- b. Battery racks, cables, connectors, and disconnect switch.
- c. Engine-mounted battery charging alternator and solid state voltage regulator.
- d. Battery Charger:
 - i. 120VAC, UL-listed, voltage regulated and equipped with float, taper and equalize charge settings.
 - ii. Analog DC ammeter and voltmeter; 12-hour equalize timer; AC and DC fuses.
 - iii. Loss of AC power, low battery voltage and high battery voltage alarm lights and contacts for remote annunciation; power on light.

C. UL Listed Skid Base

1. The pump base tank shall be a UL-142 approved double wall design constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; The Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and The Standard for Emergency and Standby Power Systems, NFPA 110.
2. The tank design shall be a Closed Top Dike Pump Base Tank. It shall be of double wall construction having a primary tank to contain the diesel fuel, held within another tank or dike, which is intended to collect and contain any accidental leakage from the primary fuel tank. The completed base tank assembly is to incorporate pump mounting locations and must be able to support four (4) times the rated load.
3. The primary tank shall be designed to withstand normal and emergency internal pressures and external loads. It shall be capable of withstanding internal air pressures of 3 to 5 psig without showing signs of excessive or permanent distortion and 25 psig hydrostatic pressure without evidence of rupture or leakage.
4. The primary and secondary tanks or dike shall have venting provisions to prevent the development of vacuum or pressure capable of distorting them as a result of the atmospheric temperature changes or while emptying or filling. The vent shall also permit the relief of internal pressures caused by exposure to fires. The vent size shall be determined by using the calculated wetted surface area in square feet (the top is excluded) in conjunction with venting capacity table 10.1 of UL-142. The tank's vent shall also be equipped with a coupling device and shall be located to facilitate connection to a vent piping system. The dike's vent may be an opening for venting directly to the atmosphere and protection from the entrance of natural elements or debris shall be provided.
5. The primary tank is to be constructed of 7-gauge ASTM A569 or A-36 hot rolled steel. Internal baffles or reinforcement plates shall be located on a maximum of 24-inch centers in tanks up to 60-inch width and on a maximum of 19.5 inch centers in tanks over 60 inch width. At least one baffle shall separate the fuel suction pipe from the fuel return line.

6. The outer tank is to be constructed in a manner to be able to support four (4) times the wet load of the pump and housing. All of the load is to be carried by the outer tank so no load or vibration stress is placed on the primary tank. If the pump base tank is wider than the pump set to be supported, structural rails are to be incorporated to span the width of the base tank so that the load is transferred to the side rails of the tank. Vertical reinforcements shall be welded to the outer sides of the secondary tank or dike at a maximum of 45-inch centers on tanks up to 30 inches high and on 24-inch centers on tanks greater than 30-inches high. At least one (1) vertical reinforcement shall be positioned adjacent to each mounting hole location.
7. Both primary and secondary tanks shall be fitted with the proper welded pipe fittings to accommodate the requirements for the fill port and normal and emergency venting.
8. The completed assembly is to be cleaned with a heated pressure wash followed by a chromium free post treatment to ensure proper paint adhesion. The tank assembly is to be painted with an epoxy ester primer and high-quality polyurethane enamel with total paint thickness of 3.5 mils. The painted tank assembly is to be baked at 180 degrees for 30 minutes to provide a hard durable finish.
9. Manufacturing and testing of this system shall be performed within the scope of Underwriters Laboratories, Inc. "Standard for Safety UL 142." A UL label shall be permanently attached to the tank system showing the following information:
 - a. The registered UL mark and the name: Underwriters Laboratories, Inc.
 - b. A control number and the word "listed"
 - c. The product's name as identified by Underwriters Laboratories Inc.
 - d. The serial number assigned by Underwriters Laboratories, Inc.
 - e. Other manufacturer's information may also be included.

D. Sound Attenuated Enclosure

- a. The engine and pump shall be completely enclosed with 14-gauge sheet metal panels backed with 1" and 2" layers of polydamp acoustical sound deadening material. The acoustical enclosure shall reduce pump and engine noise to seventy dBA or less at a distance of 30 feet. The panels shall be removable for easy access to the engine / pump for maintenance and repair. The engine control panel shall have a locking door for visual inspection. For maintenance and service needs, the pump discharge side of the trailer shall have a hinged door for quick access to the engine oil fill, fuel fill port, oil dipstick and filters.

E. Automatic Starting Control System

- a. The engine shall be equipped with a factory installed Prime Guard 2 microprocessor-based controller as supplied by Godwin Pumps of America, Inc. and designed to start/stop the engine at a signal supplied by high and low level floats or a 4-20 mA transducer.

F. Engine / Pump Control Specifications

- a. The engine shall be started, stopped, and controlled by a Prime Guard 2 high

performance state of the art digital controller as supplied by Godwin Pumps of America. The controller shall be weather proof enclosed, and contain an external weatherproof 12-position keypad accessible without the need to remove or open any protective cover or enclosure. It shall be designed to start/stop the engine at a signal supplied by high and low level floats or a 4-20 mA transducer. The Prime Guard 2 Pump Controller shall provide the following functions without modification, factory recalibration or change of chips or boards by simply accessing the keypad.

- b. The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, through ice, snow, mud, grease, etc. and maintain complete weather tight sealing of the Prime Guard 2 Panel.
- c. In automatic mode, the unit shall conserve energy and go to "sleep".
- d. The Prime Guard 2 panel shall function interchangeably from; float switches, pressure switch, or transducer as well as manual start/stop by selection at the keypad. No other equipment or hardware changes are required.
- e. The Prime Guard 2 Panel shall be capable of varying the engine speed to maintain a constant level in a process without a change to the panel other than via the keypad.
- f. The start function can be programmed to provide 3 separate functions each day for 7 days (i.e. a start, warm up, exercise cycle on two separate days at different times and for a varying length of time all via the keypad).

G. Control Panel (Manual-Automatic Key switch)

- a. In Manual Mode, Manual "Start" button starts engine and runs until "Stop" button is depressed or an emergency shutdown occurs.
- b. In Automatic Mode start/stop sequencing is initiated by either one-normally open and one-normally closed narrow angler float switches, pressure switch, transducer or a signal from a digital input.
- c. The controller shall integrate the engine safety shut-off for low-oil temperature, high-temperature, and provide over-speed protection.
- d. The controller shall include standard field adjustable parameters for engine cycle crank timer, shutdown time delay, warm-up time delay, and cool-down time delay.
- e. The Prime Guard 2 Panel shall have only one circuit board with 8 built in relays. Each relay can be named to provide any function all via the key pad without changing relays, chips, printed circuits or any hardware or software.
- f. Standard components shall consist of (24) digital inputs, (7) analog inputs, (1) magnetic pick-up input, (8) 20-amp form "C" relays, (1) RS232 port, (1)

RS485 port, (1) RS232/RS485 port, (1) J1939 port, and (1) 64X128 pixel full graphic LCD display with backlight.

- g. The industrially hardened Prime Guard 2 Panel shall withstand Vibration of 3 g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature Range of 4° to 176°F (-20°C to 80°C) and an operating humidity range of 0-95% Non-Condensing.

2.4 ANCHOR BOLTS

- A. Furnish anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment manufacturer. Provide hooked anchor bolts for direct embedment during placement of concrete. Anchor bolt material shall be Type 316 stainless steel conforming to the requirements of Section 05 05 33, Anchor Systems.

2.4 TOOLS AND SPARE PARTS

- A. The manufacturer shall furnish the following with the Emergency Backup Pump System:
 - 1. A recommended list of spare parts.
 - 2. An Operations and Maintenance manual.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspection:
 - 1. Inspect and verify that structures or surfaces on which equipment will be installed have no defects which will adversely affect installation.
 - 2. Inspect all equipment prior to installation.
 - 3. Promptly report defects which may affect Work to Engineer.

3.2 INSTALLATION

- A. General: Install in a manner and to the tolerances recommended by the equipment manufacturer and approved Shop Drawings.
- B. Manufacturer's representative shall check and approve the installation prior to operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the Owner's satisfaction.

3.3 FIELD PAINTING

- A. Field painting shall conform to the requirements of Section 09 91 00, Painting.

3.4 START-UP AND FIELD TEST

- A. Perform operating tests to demonstrate that the equipment operates without excessive vibration.
- B. Make adjustments required to place equipment in proper operating condition.

3.5 FIELD QUALITY CONTROL

- A. All equipment will be given running tests by Contractor at the job Site following installation of the equipment and controls. Should the tests indicate any malfunction, Contractor shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the Engineer, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.
- B. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 2 visits, minimum 8 hours on-Site for each visit, to the Site. The first visit shall be for assistance in the installation of equipment. Subsequent visits shall be for checking the completed installation, start-up and training of the system. Manufacturer's representative shall test operate the system in the presence of the Engineer and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
- C. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the Owner.

+ + END OF SECTION + +

SECTION 46 41 24

CONDITIONING PUMP

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install a conditioning pump complete and operational. A complete system will be provided including pumps, motors, and nozzle assemblies. The Contractor unless otherwise required in this specification section, shall supply discharge piping to nozzles, piping supports, valves, anchor bolts, gauges and other specialties. Pump suction pipe, if shown in the drawings, shall also be supplied by the Contractor. All performance and warranty requirements shall also be the responsibility of the approved manufacturer.
2. Included are motors, pumps, housings, propellers, nozzles systems and all appurtenances.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the submersible mixers Work.

C. Related Sections:

1. Section 01 65 00, Product Delivery Requirements.
2. Section 01 78 23, Operation and Maintenance Data.
3. Section 05 05 33, Anchor Systems.
4. Section 09 91 00, Painting.
5. Section 26 29 33, Control Stations.
6. Section 26 29 37, Low-Voltage Combination Magnetic Motor Starters

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Bearing Manufacturers Association, (ABMA).
2. American Gear Manufacturers Association, (AGMA).
3. American Institute of Steel Construction, Inc., (AISC).
 - a. AISC 303, Code of Standard Practice for Steel Bridges and Buildings.
 - b. AISC S326, Design, Fabrication and Erection of Structural Steel.
4. American National Standards Institute, (ANSI).
5. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 36/A 36M, Specification for Carbon Structural Steel.
 - b. ASTM A 48/A 48M, Specification for Gray Iron Castings.
6. American Welding Society, (AWS).
 - a. AWS D1.1/D1.1M, Structural Welding Code-Steel.
7. Institute of Electrical and Electronics Engineers, (IEEE).
8. National Electrical Code, (NEC).
9. National Electrical Manufacturers Association, (NEMA).

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single sludge mixing tank mixer manufacturer.
 - 2. The mixer manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this specification.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the conditioning pump manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Manufacturer's literature, illustrations, specifications, and engineering data including: materials, dimensions, weights, performance data, and part lists for all components in sufficient detail to allow an item by item comparison with the Contract Documents.
 - b. Pump and Motor test reports for furnished Pump and motors or for a previously manufactured electrically duplicate pump and motor that was tested, including running light current, locked rotor current, winding resistance measurement, high potential test, bearing inspection, and efficiency at 1/2, 3/4, and full load.
 - c. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
 - d. List of deviations from the Contract Documents.
 - e. Listing of conveyor components and materials.
 - f. Provide a copy of the manufacturer's standard warranty for parts and labor.
 - g. For all components of s mixers as appropriate, including setting drawings and instructions for installation of anchor bolts and gear reducer, including tolerances.
- B. Informational Submittals: Submit the following:
 - 1. Support Design Information:
 - a. Weight of the complete assembly.
 - b. Certificates
 - 2. Source Quality Control Submittals:
 - a. Submit results of performance tests and cable insulation tests.
 - 3. Site Quality Control Submittals:
 - a. Submit a written report giving the results of required field tests.
 - b. Submit written report of results of each visit by a manufacturer's serviceman, including purpose and time of visit, tasks performed and results obtained.

- C. Closeout Submittals: Submit the following:
 - 1. Operation and Maintenance Manuals:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts:
 - a. Furnish all required spare parts as specified in Part 2 of this specification.
 - 2. Tools:
 - a. Furnish all required special tools as specified in Part 2 of this specification.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Comply with Section 01 65 00, Product Delivery Requirements.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

- A. Description:
 - 1. Provide one (1) conditioning system consisting of one (1) wall mounted mixing nozzles with associated chopper pump as described herein and shown in the drawings. The nozzles shall be designed and positioned to produce rotation within the tank, which effectively suspends organic and inorganic material. The pattern shall produce a homogeneous concentration not to exceed +/- 10% of the total suspended solids geometric mean. The conditioning pump manufacturer shall be responsible for determining mixing assembly quantity, location, and appropriate nozzle angles.

B. Performance Criteria:

1. Schedule of Service Conditions:
 - a. Location: Bottom of Wet Well
 - b. Designation: Conditioning Pump
 - c. Total Number of Units: 1 Pump and 1 mixing nozzle.
 - d. Motor Horsepower and RPM: 10 HP, 1170 RPM
 - e. Type of Waste: Raw Wastewater
 - f. Mixer Primary Pumping Rate: 650 GPM.

2.2 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:

1. Vaughan Co , Inc.
2. Flygt Corporation
3. Anderson Pumps
2. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Nozzle:

1. Nozzles: Shall be glass-lined cast ductile iron, with 1.0" nominal wall thickness to protect against abrasive conditions, and a long straight taper length of at least 10 inches.
2. Assembly Fittings: Shall be glass-lined cast ductile iron, with 150 lb. flanged piping connection.
3. Assembly Base: Shall be fabricated carbon steel, with ¾" mounting holes for 5/8" anchor bolts.

B. Conditioning Pump:

1. The Conditioning Pump shall be a submersible chopper pump design. The pump shall be specifically designed to pump and agitate waste solids at heavy consistencies. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through, mix and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications.
2. Casing, Back Pull-Out Adapter Plate and Wear Plate: The pump casing shall be of semi-concentric design, with the first half of the circumference being cylindrical beginning after the pump outlet, and the remaining circumference spiraling outward to the 150 lb. flanged centerline discharge. Back pull-out adapter plate shall allow removal of pump components from above the casing and allow external adjustment of impeller-to-cutter bar clearance. Wear plate shall be integral to the back pull-out plate and shall include an internal cutter for stringy materials caught between the wear plate and the pump-out vanes on the back of the impeller. Casing and adapter plate shall be ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. Wear plate shall be heat-treated steel plate.

3. Impeller: Shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a maximum set clearance between the impeller and cutter bar of .020"-.030" cold. Impeller shall be cast steel, heat treated to minimum Rockwell C 60 and dynamically balanced. The impeller shall be threaded to the shaft and shall have no axial adjustments and no set screws.
4. Cutter Bar: Shall be recessed into the pump bowl and shall contain at least 2 shear bars extending diametrically across the intake opening to within 0.010-0.015" of the rotating external cutter tooth, for the purpose of preventing intake opening blockage and wrapping of debris at the shaft area. Chopper pumps utilizing individually mounted shear bars, and/or which do not have a rotating external cutter extending through to the opposite side of the shear bar to prevent intake opening blockage, shall not be acceptable. Cutter bar shall be T1 plate steel heat-treated to minimum Rockwell C 60.
5. Cutter Nut: The cutter nut shall be used to affix the impeller to the shaft, and to eliminate binding or wrapping of stringy materials at the pump inlet. The cutter nut shall consist of a hex head sufficiently sized for ease of removal and shall include an integral cast anvil which shears against the adjacent surface of the segment bars on the cutter bar. The cutter nut shall be cast steel heat treated to a minimum 60 Rockwell C Hardness. Due to the solids handling demand in this application, nuts, bolts, or other impeller securing devices that lack the ability to cut debris from the pump suction shall not be allowed on this project.
6. Upper Cutter: Shall be threaded into the back pull-out adapter plate above the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast steel, heat treated to minimum Rockwell C 60.
7. Stainless Steel Nameplates: Shall be attached to the pump giving the manufacturer's model and serial number, rated capacity, head, speed and all pertinent data.
8. Guide Rail System: Provide a non-sparking guide rail system consisting of two stainless steel guide rails, cast bronze pump guide bracket, cast ductile iron discharge elbow with mounting feet and 125 lb. flanges, upper guide rail mounting bracket, and intermediate guide brackets every 10 feet. System design shall prevent spark ignition of explosive gases during pump installation and removal.
9. Moisture and Thermal Sensor Relay: The pump manufacturer shall supply a control relay to monitor both moisture and temperature in the submersible motor. The relay shall be rated 120 VAC with an operating temperature range of -20 degrees C to +65 degrees C. The relay shall be sent to the control panel supplier for installation into the control panels.

C. Motors

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1. The submersible motor shall be U/L listed and suitable for Class I, Group D, Division I hazardous locations, rated at 20 HP maximum, 1170 RPM, 460 volts, 60 Hertz and 3 phase, with a 1.15 service factor and Class F insulation. The motor shall be rated for 15 minutes of in-air operation. Motor shall have dual moisture sensing probes, and two normally closed automatic resetting thermostats connected in series and imbedded in adjoining phases. Motor frame shall be cast iron, and all hardware and shaft shall be stainless steel.
2. Motors shall comply with the latest ANSI, NEMA, ABMA and IEEE Standards as a minimum.
3. Locked rotor current shall be as specified in NEMA standards.
4. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of service, and shall have a minimum B-10 life of 30,000 hours.
5. Motors shall have a stainless steel nameplate which shall provide the following: type, frame, insulation, class, Hp, full load current, RPM, centigrade degree rise, manufacturer's name and serial number, model number, voltage, locked rotor KVA code, bearing numbers and a connection diagram.
6. Mechanical Seals: Motor shall have tandem mechanical seals. Lower pump seal shall be stainless steel 20 welded metal bellows type fitted with silicon carbide seal faces to provide long life expectancy in the presence of grit and abrasive solids. The seal shall ride on a 400 series stainless steel motor shaft, with the seal bellows tension set by 3 set screws. Seals shall be tested for flatness within 2 Helium light bands under a Helium light source and optical flat.

D. Shafts:

1. Propeller shaft: Stainless steel, ANSI 431.
2. Motor shaft: Stainless steel, ANSI 431.

E. Shaft Bearings:

1. Mixer motor shaft shall rotate on two permanently lubricated bearings. Inner bearing shall be a single row deep groove ball bearing and outer bearing a two-row angular contact ball bearing or a single row deep groove ball bearing.
2. Propeller shaft shall be supported by two single-row, deep-groove ball bearings.

F. Power Cable:

1. Provide submersible hypalon jacketed, Type SPC cable (power plus ground plus control), UL listed and labeled. No splices will be allowed in the cable.
2. Size conductors in accordance with NEC Standards.

G. Control Panel:

- a. Provided under Section 26 29 37, Low-Voltage Combination

Magnetic Motor Starter, and Section 26 29 33, Control Stations.

2.4 ANCHOR BOLTS

- A. Furnish anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment manufacturer. Provide hooked anchor bolts for direct embedment during placement of concrete. Anchor bolt material shall be Type 316 stainless steel conforming to the requirements of Section 05 05 33, Anchor Systems.

2.5 TOOLS AND SPARE PARTS

- A. Furnish and deliver the following boxed and labeled:
 - 1. The following required spare parts are based on Flygt submersible mixers. Furnish comparable spare parts if mixers provided by another manufacturer.
 - 2. Each mixer shall be furnished with the following spare parts and tools.
 - a. Eight grommets.
 - b. Four O-rings of each size required by unit.
 - c. Two motor shaft lip seals.
 - d. Two rotor locking screws.
 - e. Two shaft nuts.
 - f. One driven gears.
 - g. Six expansion sleeves.
 - h. Two hex head propeller bolts.
 - i. Two plastic propeller caps.
 - j. Two sets of any special tools required for normal operation and maintenance.
- B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.
- C. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of one year. The list shall describe each part, the quantity recommended, and the unit price of the part.

2.6 SURFACE PREPARATION AND PAINTING

- A. Mixers, pumps, motors, frames, ferrous metal surfaces, appurtenances, etc., shall receive shop primer coating conforming to the requirements of Section 09 91 00, Painting. The pump exterior shall be solvent washed, sandblasted, and coated with minimum 30 MDFT Tnemec Perma-Shield PL Series 431 epoxy
- B. Surface preparation and painting shall conform to the requirements of Section 09 91 00, Painting.
- C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

- D. Contractor shall certify, in writing, that the shop primer and finish coating system conforms to the requirements of Section 09 91 00, Painting.
- E. Nozzle Assemblies shall be SSPC-SP5 commercial sandblasted and finished with Fusion Bonded Epoxy Coating resistant to wastewater, hydrocarbons, and harsh chemicals, with a long history in sewage service and certified for potable water. All fasteners shall be 316 stainless steel

2.7 LUBRICANTS

- A. Furnish all oil and grease required for initial operation. Use products as recommended by the manufacturer.

2.8 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Perform a motor and cable insulation test for moisture content or insulation defects.
 - 2. Prior to submergence, run the unit dry to establish correct rotation and mechanical integrity.
 - 3. Run the mixer for 30 minutes submerged.
 - 4. After initial operating test, stop motor and wait 30 minutes while still submerged, then perform the insulation test again with the motor still submerged.
 - 5. Each test shall be witnessed by a Registered Professional Engineer, who may be an employee of the manufacturer. The Registered Professional Engineer shall sign and seal the required tests were performed. The test results shall show the serial numbers of all equipment tested.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspection:
 - 1. Inspect and verify that structures or surfaces on which equipment will be installed have no defects which will adversely affect installation.
 - 2. Inspect all equipment prior to installation.
 - 3. Promptly report defects which may affect Work to Engineer.

3.2 INSTALLATION

- A. General: Install in a manner and to the tolerances recommended by the equipment manufacturer and approved Shop Drawings.
- B. Manufacturer's representative shall check and approve the installation prior to operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the Owner's satisfaction.

3.3 FIELD PAINTING

- A. Field painting shall conform to the requirements of Section 09 91 00, Painting.

3.4 START-UP AND FIELD TEST

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- A. Perform operating tests to demonstrate that the equipment operates without excessive vibration.
- B. Make adjustments required to place equipment in proper operating condition.
- C. Mixing Tests:
 - 1. Tests shall verify that contents of each tank are thoroughly mixed and that mixer is capable of continuous operation at completely unsubmerged conditions for not less than two hours.
 - 2. Submit proposed test program and test procedures, method of measurement, and criteria for acceptance to be used to Engineer for approval before start of tests.
 - 3. Submit report of test results.

3.5 FIELD QUALITY CONTROL

- A. All equipment will be given running tests by Contractor at the job Site following installation of the equipment and controls. Should the tests indicate any malfunction, Contractor shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the Engineer, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.
- B. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 2 visits, minimum 8 hours on-Site for each visit, to the Site. The first visit shall be for assistance in the installation of equipment. Subsequent visits shall be for checking the completed installation, start-up and training of the system. Manufacturer's representative shall test operate the system in the presence of the Engineer and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
- C. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the Owner.

+ + END OF SECTION + +